BANASTHALI VIDYAPITH

Bachelor of Technology
(Electronics and Instrumentation Engineering/
Electrical and Electronics Engineering/
Mechatronics Engineering/
Electronics and Communication Engineering)

Curriculum Structure

First Semester Examination, December, 2020
Second Semester Examination, April/May, 2021
Third Semester Examination, December, 2021
Fourth Semester Examination, April/May, 2022
Fifth Semester Examination, December, 2022
Sixth Semester Examination, April/May, 2023
Seventh Semester Examination, December, 2023
Eighth Semester Examination, April/May, 2024

BANASTHALI VIDYAPITH
P.O. BANASTHALI VIDYAPITH
(Rajasthan)-304022

July, 2020

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No. F. 9-6/81-U.3
Government of India
Ministry of Education and Culture
(Department of Education)

New Delhi, the 25th October, 1983

N O T I F I C A T I O N

In exercise of the powers conferred by Section 3 of the University Grants Commission Act, 1956 (3 of 1956) the Central Government, on the advice of the Commission, hereby declare that Banasthali Vidyapith, P. O. Banasthali Vidyapith, (Rajasthan) shall be deemed to be a University for the purpose of the aforesaid Act.

Sd/-
(M. R. Kolhatkar)
Joint Secretary of the Government of India

N O T I C E

Changes in Bye-laws/Syllabi and Books may from time to time be made by amendment or remaking, and a Candidate shall, except in so far as the Vidyapith determines otherwise, comply with any change that applies to years she has not completed at the time of change.

CONTENTS

Department of Automation

Electronics and Instrumentation Engineering

The Bachelor of Technology (B.Tech.) program in Electronics and Instrumentation Engineering (EIE) has a strong blend of Measurement, Control and Automation. The program deals with control and monitoring of sophisticated real world problems. This branch has scope of Electronic Measurement, Process Control, Robotics, Automation, Control System Design and Optimization. The program was started in 2011 and progressing on high growth path with best practices focusing on student centric approach. The department is a blend of dynamic and well experienced faculties. The main aim of this programme is to transform the student into professionally competent and socially sensitive engineers capable of working in multicultural global environment through quality education in the field of Electronics and Instrumentation Engineering.

The aim of this programme is to enhance learning and research spirit in the students by making them acquaintance with modern technologies in Electronics and Instrumentation to operate the growing needs of the industries. The motive is to inculcate continuous practical knowledge through skill based learning approach using team works and leadership qualities. The course will bestow students, the capability to provide cost effectiveness solutions for social needs with deliberation surrounding.

Programme Educational Objectives

- To acquaint technical skills in the students for designing engineering systems by using instrumentation and related field of electronics.
- To create professional abilities that nurtures them for new employment opportunities in advanced areas of Electronics and Instrumentation as well as Electronics Engineering.
- To adorn with skills for solving technical problems related to Robotics, Embedded system, Biomedical, Fiber Optics, Digital Control system, Virtual Instrumentation, Analytic Instrumentation, Process control.
- To develop overall personality having attributes of ethical and moral values using women empowerment, humanities, and sociological courses.

Programme Outcomes

A graduate in Electronics and Instrumentation Engineering will be able to: -

PO 1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5. **Modern tool usage:** Demonstrate their technical ability to design and analyze Electronics and Instrumentation circuits, computer based programs through Programmable Logic Controller (PLC), MATLAB, Lab-VIEW, AUTOCAD and Arduino and IOT.

PO 6. **The Engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10. Communication: Communicate effectively 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 documentation, make effective presentations, and give and receive clear instructions.

PO 11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PO 13. Self learning and entrepreneurship: Graduate will be able to participate and succeed in campus placements and competitive examinations like Public sector, GATE, GRE etc. An understanding of the industry needs through direct exposure with the industries under the Entrepreneurship Development Cell.

PO 14. Higher education and research: An ability to take interest in higher education, research avenues through various trainings and research laboratory exposure.

Electrical and Electronics Engineering

Electrical and Electronics Engineering is a professional engineering discipline that deals with the development of technologies for generating and harnessing electricity for a wide range of applications. The field first became an identifiable occupation in the late nineteenth century, with the commercialization of the electric telegraph and power supply. The field now covers a range of sub disciplines, including those that deal with power, control systems, electronics, signal processing and telecommunications.

Electrical engineering surrounds us everywhere in modern society. The electrical engineer supplies us with the ability to harness electricity which has transformed our lives. It gives us light, heat, entertainment, communication systems and comfort. Electrical engineers create and design products and information systems using scientific principles combined with natural curiosity, problem-solving and innovation.

Electrical engineers work with electricity in a variety of areas - aircraft and automobiles; broadcasting and communications systems; lighting and wiring in buildings; machinery controls; power generating and transmitting; radar and navigation systems. They can be involved with the design of new products as well as testing equipment and solving problem

Electrical engineering program offer high quality education to students for abreast of latest global industrial and research requirements and fulfill responsibility towards community. The motive of the course is to transform students into professionally competent and socially sensitive engineers capable of working in multicultural global environment through quality education in the field of Electrical and Electronics Engineering.

Programme Educational Objective

- To prepare undergraduate students with appropriate blend of theoretical foundations, experimentation & technical implementation to comprehend and pinpoint problems in the field of electrical engineering.
- To offer students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve electrical engineering problems and also to pursue higher studies. Student will be able to employ her knowledge along with essential techniques & tools for modern engineering applications.

- To train students with good scientific and electrical engineering breadth so as to comprehend, analyze, design, and create novel products and solutions for the real life problems in the present electrical system.
- To inculcate professional and ethical attitude and skills like communication, teamwork, computational ability to relate electrical engineering issues to broader social context in students.
- To educate students with an academic environment aware of excellence, leadership, and the life-long learning needed for a successful professional career through independent studies, thesis, internships, *etc.*

Programme Outcomes

A graduate in Electrical and Electronics Engineering will be able to: -

PO 1. **Engineering knowledge**: Graduates will demonstrate knowledge of advanced mathematics, science and electrical engineering with the ability to apply the theoretical knowledge and concepts to the disciplines of electrical engineering.

PO 2. **Problem analysis:** Graduates will demonstrate an ability to identify, formulate, pinpoint and solve Electrical engineering problems keeping in view the present day power and energy requirement and its future prospect.

PO 3. **Design/development of solutions:** Graduate will demonstrate an ability to design and analyze electrical and power electronic circuits and conduct experiments enable to design, construct and operate complex interconnected power systems.

PO 4. **Conduct investigations of complex problems:** Graduates will demonstrate an ability to design study and analyze the digital and analog systems and components that serve as the fundamental components of the power engineering methods being increasingly used with the new technological advances.

PO 5. **Environment and sustainability:** Graduates will demonstrate an ability to visualize and work on laboratory and identify the theoretical models as predictors of real world behavior. This may include evaluating, establishing of validating a relationship between data and underlying physical principles.

PO 6. **Modern tool usage:** Graduate will demonstrate skills to use modern engineering tools, software, equipment to design, protect or assemble the system using specific methodologies with the help of appropriate tools to satisfy requirements. Graduates will demonstrate knowledge of professional and computer language skills that will eventually develop them into skilled researchers in an atmosphere that is technically advanced and conductive.

PO 7. **Communication:** Graduate will be able to communicate effectively in both verbal and written form. They will develop a better presentation skill on academic and personal grounds that will enhance their personality in all aspects.

PO 8. **The engineer and society:** Graduate will understand the impact of engineering solutions on the society and also be aware of contemporary issues relating to the exhausting resources and alternatives to continue uninterrupted power supply.

PO 9. **Individual and team work:** Graduate will develop confidence, self-motivation, positive belief, consistency, perseverance and team work.

PO 10. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 11. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PO 12. **Self learning and entrepreneurship:** Graduate will be able to participate and succeed in campus placements and competitive examinations like Public sector, GATE, GRE etc. An understanding of the industry needs through direct exposure with the industries under the Entrepreneurship Development Cell.

PO 13. **Higher education and research:** An ability to take interest in higher education, research avenues through various trainings and research laboratory exposure.

Mechatronics Engineering

Automation is playing an important role in the field of engineering day by day by improving efficiency and providing faster outputs. Automation comprises essence of Electronics, Electrical, Instrumentation, Information Technology and Mechanical Engineering which contribute together to automate any system. That is why Mechatronics Engineering was inherently introduced. The concept behind the Mechatronics Engineering was to produce a design solution that unifies each of these various subfields. This branch invests in the creation and implementation of smart devices, machines, processes and systems. The often-expressed desire to be at the forefront of a high-tech, knowledge-based economy opens plenty of career options that require diverse, multi-skilled graduates.

Hence it opens up opportunities for Mechatronics Engineering graduates to work in companies of all sizes and fields – from start-ups to multinational corporations, in areas from research to high-value manufacturing.

The Mechatronics Engineering impart high quality engineering education that combines academics with extensive practical experience and prepares our engineers for leadership in industry, business, academia and government.

Programme Educational Objectives

- To offer industry oriented courses like pneumatics, Hydraulics, Computer Integrated Manufacturing, Programmable Logic Controller etc.
- To acquaint technical skills in the students for designing engineering systems by using concepts of electrical, electronics, Mechanical and Information Technology.
- To create professional abilities that nurtures them for new employment opportunities in advanced areas of Mechatronics Engineering.
- To develop overall personality having attributes of ethical and moral values using women empowerment, humanities, and sociological courses.
- To impart training to enable the students to solve the real time problems related to the field of Mechatronics Engineering and allied areas demanded by the industry and society.

Programme Outcomes

A graduate in Mechatronics Engineering will be able to: -

PO 1. **Engineering Knowledge:** Understand and apply the recent technological developments in Engineering to develop products to cater to the Societal & industrial needs.

PO 2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. **Design/development of solutions:** Design & develop solutions for complex problems in the entire spectrum of automation technology. Think critically, follow innovations and developments in science and technology, demonstrate personal and organizational entrepreneurship and engage in life-long learning in various subjects.

PO 4. **Individual and Team:** Take individual and team responsibility, function effectively and respectively as an individual and a member or a leader of a team; and have the skills to work effectively in multi-disciplinary teams.

PO 5. **Modern tool usage:** Demonstrate their technical ability to design and analyze Electronics and Instrumentation circuits, computer based programs through Programmable Logic Controller (PLC), MATLAB, Lab-VIEW, AUTOCAD and Arduino and IOT.

PO 6. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 7. **Life Long Learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PO 8. **The Engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 9. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental

contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 10. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 11. Self learning and entrepreneurship: Graduate will be able to participate and succeed in campus placements and competitive examinations like Public sector, GATE, GRE etc. An understanding of the industry needs through direct exposure with the industries under the Entrepreneurship Development Cell.

PO 12. Higher education and research: An ability to take interest in higher education, research avenues through various trainings and research laboratory exposure.

Electronics and Communication Engineering

Programme Educational Objectives

The B.Tech. (ECE) programme aims for the holistic development of students through the unique and innovative fivefold educational ideology of Banasthali Vidyapith. Electronics now become the integral part of our lives. As the world continues to rely on Electronics technology, there is a great requirement for those engineers who are able to design, create, and maintain the many products and systems that support electronics technology. Electronics engineers develop innovative technology solutions in a wide range of areas from handheld communications to solar panels; from cardiac pacemakers to autonomous robots; from wireless networks to bio-engineered sensors that detect dangerous pathogens; and intelligent surveillance systems that perform face and motion recognition.

The program aims to deepen the knowledge and skills of the students on the basic concepts and theories that will equip them in their professional work involving analysis, systems implementation, operation, production, and maintenance of the various applications in the field of Electronics and Communications. The curriculum is designed in a way that it will equip students with a solid grasp of mathematical, scientific, and engineering concepts, through classroom education and laboratory exercises. Graduates of the program are expected to develop and use professional skills that facilitate their continued carrier growth well beyond their graduation.

The main objectives of the program are:

- To provide students solid foundation in mathematical and engineering fundamentals required to solve engineering problems and also to pursue advanced studies. This serves them lifelong in their professional domain as well as higher education.
- To develop an ability to integrate fundamental knowledge of basic science, mathematics and engineering to work on complex problems in the field of Electronics and Communication.
- To prepare engineers to work in inter-disciplinary environment, either independently or in a team, and demonstrate leadership qualities.
- Practice the ethics of their profession, consistent with a sense of social responsibility and develop their engineering design, problem–solving

skills and aptitude for innovations as they work individually and in multi-disciplinary teams.

- Inculcate a lifelong learning culture.
- To formulate problems and projects and to plan a process for solution.
- Communicate effectively and manage resources skilfully as members and leaders of the profession.
- To prepare competent engineers at various national and international levels.

Programme Outcomes

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and Electronics engineering to the solution of complex engineering problems.

PO2. **Problem analysis:** Review, Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions:** Develop solutions for complex engineering problems and design system components/processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems:** Use scientific and engineering knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage:** Apply appropriate techniques, resources, and modern engineering tools including MATLAB, LabView, Proteus, VHDL, Arduino and related hardware to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society:** Apply reasoning gained by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental

contexts, and demonstrate the knowledge for sustainable development.

PO8. **Ethics:** Apply ethical principles and commit to professional ethics responsibilities and norms of the engineering practice.

PO9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary surroundings.

PO10. **Communication Skill:** Communicate effectively 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 documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Curriculum Structure

Bachelor of Technology (Electronics and Instrumentation Engineering)

First Year

Semester - I

Course Code	Course Name	L	T	P	C*
BVF 011/ BVF 014	General English / सामान्य हिन्दी	2	0	0	2
	Core Foundation Course - I	2	0	0	2
MATH 103/ MATH 107	Calculus/Linear Algebra	3	1	0	4
PHY 101/ PHY 106	Applied Optics/Modern Physics	3	1	0	4
CHEM 101/ BIO 101	Chemistry/Biology	3	1	0	4
CHE 102/ PHY 109	Thermodynamics/Engineering Mechanics	3	1	0	4
CS 109/ EEE 101	Computer Fundamentals and Programming/Electrical Engineering	4	0	0	4
CS 109L/ EEE 101L	Computer Fundamentals and Programming Lab /Electrical Engineering Lab	0	0	4	2
ENGG 101L/ ENGG 103L	Engineering Drawing and Graphics Lab/ Measurement Techniques Lab	0	0	6	3
Semester Total:		**20**	**4**	**10**	**29**

Semester - II

Course Code	Course Name	L	T	P	C*
BVF 014/ BVF 011	सामान्य हिन्दी /General English	2	0	0	2
	Core Foundation Course - II	2	0	0	2
MATH 107/ MATH 103	Linear Algebra/Calculus	3	1	0	4
PHY 106/ PHY 101	Modern Physics/Applied Optics	3	1	0	4
BIO 101/ CHEM 101	Biology/Chemistry	3	1	0	4
PHY 109/ CHE 102	Engineering Mechanics/Thermodynamics	3	1	0	4
EEE 101/ CS 109	Electrical Engineering / Computer Fundamentals and Programming	4	0	0	4
EEE 101L/ CS 109L	Electrical Engineering Lab / Computer Fundamentals and Programming Lab	0	0	4	2
ENGG 103L/ ENGG 101L	Measurement Techniques Lab /Engineering Drawing and Graphics Lab	0	0	6	3
	Semester Total:	**20**	**4**	**10**	**29**

Second Year

Semester - III

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - III	2	0	0	2
	Elective Foundation Course - I	2	0	0	2
MATH 209/ MATH 210	Complex Variables/Differential Equations	3	1	0	4
ENGG 201/ ENGG 202	Structure and Properties of Materials/Basic Electronics	4	0	0	4
CS 209	Data Structures	4	0	0	4
CS 209L	Data Structures Lab	0	0	4	2
EEE 203	Network Analysis and Synthesis	3	1	0	4
EEE 203L	Network Analysis and Synthesis Lab	0	0	2	1
ELE 206	Digital Electronics	3	1	0	4
ELE 201L	Digital Electronics Lab	0	0	2	1
EIE 203S	Seminar	0	0	2	1
	Semester Total:	**21**	**3**	**10**	**29**

Semester - IV

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - IV	2	0	0	2
	Elective Foundation Course - II	2	0	0	2
MATH 210/ MATH 209	Differential Equations/Complex Variables	3	1	0	4
ENGG 202/ ENGG 201	Basic Electronics/Structure and Properties of Materials	4	0	0	4
CS 214	Object Oriented Programming	4	0	0	4
CS 214L	Object Oriented Programming Lab	0	0	4	2
EIE 204	Electrical and Electronics Measurements	4	0	0	4
EIE 202L	Electrical and Electronics Measurements Lab	0	0	2	1
MCTR 201	Pneumatic Engineering	4	0	0	4
MCTR 201L	Pneumatic Engineering Lab	0	0	2	1
	Semester Total:	**23**	**1**	**8**	**28**

Third Year

Semester - V

Course Code	Course Name	L	T	P	C*
	Vocational Course - I	2	0	0	2
	Core Foundation Course - V/Elective Foundation Course - III	2	0	0	2
ECO 307/ MGMT 310	Fundamentals of Economics/Principles of Management	3	0	0	3
STAT 204/ MATH 311	Probability and Statistical Methods/Numerical Methods	3	1	0	4
ELE 311	Analog Integrated Circuits	3	1	0	4
ELE 301L	Analog Integrated Circuits Lab	0	0	2	1
ELE 509	Microprocessors and Microcontrollers	4	0	0	4
ELE 306L	Microprocessors and Microcontrollers Lab	0	0	2	1
EIE 308	Industrial Instrumentation	4	0	0	4
EIE 308L	Industrial Instrumentation Lab	0	0	2	1
EIE 309	Linear Control System	3	1	0	4
EIE 309L	Linear Control System Lab	0	0	2	1
	Semester Total:	**24**	**3**	**8**	**31**

Semester - VI

Course Code	Course Name	L	T	P	C*
	Vocational Course - II	2	0	0	2
	Elective Foundation Course - III/Core Foundation Course - V	2	0	0	2
MGMT 310/ ECO 307	Principles of Management/Fundamentals of Economics	3	0	0	3
MATH 311/ STAT 204	Numerical Methods/Probability and Statistical Methods	3	1	0	4
MCTR 305	Robotics and Control	4	0	0	4
MCTR 305L	Robotics and Control Lab	0	0	2	1
EEE 308	Power Electronics	3	1	0	4
EEE 304L	Power Electronics Lab	0	0	2	1
EIE 307	Industrial Automation	4	0	0	4
EIE 307L	Industrial Automation Lab	0	0	2	1
EIE 312P	Project	0	0	4	2
	Semester Total:	**21**	**2**	**10**	**28**

Fourth Year

Semester - VII

Course Code	Course Name	L	T	P	C*
EIE 310	Process Control	4	0	0	4
EIE 310L	Process Control Lab	0	0	2	1
ECE 411	Communication Engineering	4	0	0	4
MCTR 419	Mechatronics Systems	4	0	0	4
MCTR 419L	Mechatronics Systems Lab	0	0	4	2
ELE 410	Digital Signal Processing	3	1	0	4
ELE 304L	Digital Signal Processing Lab	0	0	2	1
	Discipline Elective	4	0	0	4
	Open Elective	4	0	0	4
	Semester Total:	**23**	**1**	**8**	**28**

Semester - VIII

Course Code	Course Name	L	T	P	C*
EIE 419P	UIL Project	0	0	48	24
	Reading Elective	0	0	4	2
	Semester Total:	**0**	**0**	**52**	**26**

List of Discipline Elective

Course Code	Course Name	L	T	P	C*
EIE 408	Artificial Neural Network and Fuzzy Logic	4	0	0	4
EEE 402	Energy Efficiency and Conservation	4	0	0	4
EIE 415	Non-linear Control system	4	0	0	4
EIE 402	Digital Control Systems	4	0	0	4
EIE 401	Analytical Instrumentation	4	0	0	4
EIE 413	Fiber Optic and Laser Instrumentation	4	0	0	4
EIE 301	Biomedical Instrumentation	4	0	0	4
EIE 306	Virtual Instrumentation	4	0	0	4
EIE 417	Power Plant Engineering	4	0	0	4
CS 401	Artificial Intelligence	4	0	0	4
IT 412	Internet of Things	4	0	0	4
CS 450	Machine Learning	4	0	0	4
CS 441	Computer Vision	4	0	0	4
CS 433	Soft Computing	4	0	0	4

List of Reading Electives

Fundamental of Semiconductor Devices

Principles of Signals and Systems

Advance power electronics and Control

Environmental Quality Monitoring & Analysis

Advance Power Electronics and Control

Electromagnetic Compatibility

Antennas

Introduction to Photonics

Transmission lines and electromagnetic waves

Biomedical signal processing

Embedded System Design With ARM

Introduction To Industry 4.0 And Industrial Internet Of Things

Mathematical methods and techniques in signal processing

Analog IC Design

Industrial Automation and Control

Non-Conventional Energy Resources

Deep Learning

Quality Design And Control

Interfacing with Arduino

Building Arduino robots and devices

Introduction to Python for Data Science

Industry 4.0

Metal Cutting And Machine Tools

Solar Photovoltaics : Principles, Technologies & Materials

Introduction to Internet of Things

Introduction to Machine Learning

Python for Data Science

An Introduction to Artificial Intelligence

List of Core Foundation Course

Course Code	Course Name	L	T	P	C*
BVF 002	Environment Studies	2	0	0	2
BVF 013	Indian Cultural Heritage	2	0	0	2
BVF 017	Selected Writings of Great Authors - I	2	0	0	2
BVF 020	Women in Indian Society	2	0	0	2
BVF 015	Parenthood and Family Relation	2	0	0	2

List of Elective Foundation Course

Course Code	Course Name	L	T	P	C*
BVF 016	Science of Happiness	2	0	0	2
BVF 012	Human Body and Health	2	0	0	2
BVF 010	Design Thinking	2	0	0	2
BVF 019	Universal Human Values	2	0	0	2
BVF 018	Selected Writings of Great Authors - II	2	0	0	2

List of Vocational Courses

Course Code	Course Name	L	T	P	C*
VOC 011L	Basic Dress Making	0	0	4	2
VOC 005L	Dress Designing	0	0	4	2
VOC 014	Entrepreneurship - I	2	0	0	2
VOC 015	Entrepreneurship - II	2	0	0	2
VOC 020	Radio Production - I	2	0	0	2
VOC 021	Radio Production - II	2	0	0	2
VOC 022	Web Designing and Internet Technology-I	1	0	0	1
VOC 022L	Web Designing and Internet Technology-I Lab	0	0	2	1
VOC 023	Web Designing and Internet Technology-II	1	0	0	1
VOC 023L	Web Designing and Internet Technology-II Lab	0	0	2	1
VOC 009	Library Science - I	1	0	0	1
VOC 009L	Library Science – I Lab	0	0	2	1
VOC 010	Library Science – II	1	0	0	1
VOC 010L	Library Science – II Lab	0	0	2	1
VOC 018	Photography - I	0	0	4	2
VOC 019	Photography - II	0	0	4	2
VOC 016	Introduction to Artificial Intelligence - I	2	0	0	2
VOC 017	Introduction to Artificial Intelligence - II	2	0	0	2
VOC 012	Computer Assisted Learning and Teaching	1	0	0	1
VOC 012L	Computer Assisted Learning and Teaching Lab	0	0	2	1
VOC 013	Emerging Technologies for Learning and Teaching	2	0	0	2

Student can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester from Semesters III onwards with prior permission of respective heads and time table Permitting.

Every Student shall also opt for:
Five Fold Education: Physical Education I, Physical Education II,
Five Fold Education: Aesthetic Education I, Aesthetic Education II,
Five Fold Education: Practical Education I, Practical Education II
one each semester

* **L - Lecture hrs/week ; T - Tutorial hrs/week;**
P - Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C- Credit Points of the Course

Note: Syllabus of Foundation and Vocational courses are available in separate booklet, Curriculum Structure and Syllabus Foundation and Vocational Courses.

Curriculum Structure

Bachelor of Technology (Electrical and Electronics Engineering)

First Year

Semester - I

Course Code	Course Name	L	T	P	C*
BVF 011/ BVF 014	General English / सामान्य हिन्दी	2	0	0	2
	Core Foundation Course - I	2	0	0	2
MATH 103/ MATH 107	Calculus/Linear Algebra	3	1	0	4
PHY 101/ PHY 106	Applied Optics/Modern Physics	3	1	0	4
CHEM 101/ BIO 101	Chemistry/Biology	3	1	0	4
CHE 102/ PHY 109	Thermodynamics/Engineering Mechanics	3	1	0	4
CS 109/ EEE 101	Computer Fundamentals and Programming/Electrical Engineering	4	0	0	4
CS 109L/ EEE 101L	Computer Fundamentals and Programming Lab /Electrical Engineering Lab	0	0	4	2
ENGG 101L/ ENGG 103L	Engineering Drawing and Graphics Lab/ Measurement Techniques Lab	0	0	6	3
	Semester Total:	**20**	**4**	**10**	**29**

Semester - II

Course Code	Course Name	L	T	P	C*
BVF 014/ BVF 011	सामान्य हिन्दी /General English	2	0	0	2
	Core Foundation Course - II	2	0	0	2
MATH 107/ MATH 103	Linear Algebra/Calculus	3	1	0	4
PHY 106/ PHY 101	Modern Physics/Applied Optics	3	1	0	4
BIO 101/ CHEM 101	Biology/Chemistry	3	1	0	4
PHY 109/ CHE 102	Engineering Mechanics/ Thermodynamics	3	1	0	4
EEE 101/ CS 109	Electrical Engineering / Computer Fundamentals and Programming	4	0	0	4
EEE 101L/ CS 109L	Electrical Engineering Lab / Computer Fundamentals and Programming Lab	0	0	4	2
ENGG 103L/ ENGG 101L	Measurement Techniques Lab /Engineering Drawing and Graphics Lab	0	0	6	3
	Semester Total:	**20**	**4**	**10**	**29**

Second Year

Semester - III

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - III	2	0	0	2
	Elective Foundation Course - I	2	0	0	2
MATH 209/ MATH 210	Complex Variables/Differential Equations	3	1	0	4
ENGG 201/ ENGG 202	Structure and Properties of Materials/Basic Electronics	4	0	0	4
CS 209	Data Structures	4	0	0	4
CS 209L	Data Structures Lab	0	0	4	2
ELE 202	Electromagnetic Field Theory	4	0	0	4
ELE 206	Digital Electronics	3	1	0	4
ELE 201L	Digital Electronics Lab	0	0	2	1
EEE 204S	Seminar	0	0	2	1
	Semester Total:	**22**	**2**	**8**	**28**

Semester - IV

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - IV	2	0	0	2
	Elective Foundation Course - II	2	0	0	2
MATH 210/ MATH 209	Differential Equations/Complex Variables	3	1	0	4
ENGG 202/ ENGG 201	Basic Electronics/Structure and Properties of Materials	4	0	0	4
CS 214	Object Oriented Programming	4	0	0	4
CS 214L	Object Oriented Programming Lab	0	0	4	2
EIE 204	Electrical and Electronics Measurements	4	0	0	4
EIE 202L	Electrical and Electronics Measurements Lab	0	0	2	1
EEE 203	Network Analysis and Synthesis	3	1	0	4
EEE 203L	Network Analysis and Synthesis Lab	0	0	2	1
	Semester Total:	**22**	**2**	**8**	**28**

Third Year

Semester - V

Course Code	Course Name	L	T	P	C*
	Vocational Course - I	2	0	0	2
	Core Foundation Course - V/Elective Foundation Course - III	2	0	0	2
ECO 307/ MGMT 310	Fundamentals of Economics /Principles of Management	3	0	0	3
STAT 204/ MATH 311	Probability and Statistical Methods/Numerical Methods	3	1	0	4
ELE 311	Analog Integrated Circuits	3	1	0	4
ELE 301L	Analog Integrated Circuits Lab	0	0	2	1
EEE 306	Electrical Machines -I	3	1	0	4
EEE 202L	Electrical Machines –I Lab	0	0	2	1
EEE 309	Power System-I	3	1	0	4
EEE 309L	Power System-I Lab	0	0	2	1
EIE 309	Linear Control System	3	1	0	4
EIE 309L	Linear Control System Lab	0	0	2	1
	Semester Total:	**22**	**5**	**8**	**31**

Semester - VI

Course Code	Course Name	L	T	P	C*
	Vocational Course - II	2	0	0	2
	Elective Foundation Course - III/Core Foundation Course - V	2	0	0	2
MGMT 310/ ECO 307	Principles of Management/ Fundamentals of Economics	3	0	0	3
MATH 311/ STAT 204	Numerical Methods/Probability and Statistical Methods	3	1	0	4
EEE 307	Electrical Machines-II	3	1	0	4
EEE 301L	Electrical Machines-II Lab	0	0	2	1
EEE 308	Power Electronics	3	1	0	4
EEE 304L	Power Electronics Lab	0	0	2	1
EEE 310	Power System-II	4	0	0	4
EEE 310L	Power System-II Lab	0	0	2	1
EEE 311P	Project	0	0	4	2
	Semester Total:	**20**	**3**	**10**	**28**

Fourth Year

Semester - VII

Course Code	Course Name	L	T	P	C*
ELE 410	Digital Signal Processing	3	1	0	4
ELE 304L	Digital Signal Processing Lab	0	0	2	1
EEE 404	Switch Gear and Protection	4	0	0	4
EEE 411L	Switch Gear and Protection Lab	0	0	2	1
ECE 411	Communication Engineering	4	0	0	4
ELE 509	Microprocessors and Microcontrollers	4	0	0	4
ELE 306L	Microprocessors and Microcontrollers Lab	0	0	2	1
	Discipline Elective	4	0	0	4
	Discipline Elective Lab	0	0	2	1
	Open Elective	4	0	0	4
Semester Total:		**23**	**1**	**8**	**28**

Semester - VIII

Course Code	Course Name	L	T	P	C*
EEE 412P	UIL Project	0	0	48	24
	Reading Elective	0	0	4	2
Semester Total:		**0**	**0**	**52**	**26**

List of Discipline Elective

Course Code	Course Name	L	T	P	C*
EEE 401	Electric Drives and Control	4	0	0	4
EEE 401L	Electric Drives and Control Lab	0	0	2	1
EEE 409	Power System Operation and Control	4	0	0	4
EEE 409L	Power System Operation and Control Lab	0	0	2	1
EEE 410	Power System Restructuring and Deregulation	4	0	0	4
EEE 410L	Power System Restructuring and Deregulation Lab	0	0	2	1
EIE 307	Industrial Automation	4	0	0	4
EIE 307L	Industrial Automation Lab	0	0	2	1
EIE 310	Process Control	4	0	0	4
EIE 310L	Process Control Lab	0	0	2	1
MCTR 402	Mechatronics	4	0	0	4
MCTR 402L	Mechatronics Lab	0	0	2	1
MCTR 403	Robotics and Automation	4	0	0	4
MCTR 403L	Robotics and Automation Lab	0	0	2	1

List of Reading Electives

Fundamental of Semiconductor Devices

Principles of Signals and Systems

Advance power electronics and Control

Environmental Quality Monitoring & Analysis

Advance Power Electronics and Control

Electromagnetic Compatibility

Antennas

Introduction to Photonics

Transmission lines and electromagnetic waves

Biomedical signal processing

Embedded System Design With ARM

Introduction To Industry 4.0 And Industrial Internet Of Things

Mathematical methods and techniques in signal processing

Analog IC Design

Industrial Automation and Control

Non-Conventional Energy Resources

Deep Learning

Quality Design And Control

Interfacing with Arduino

Building Arduino robots and devices

Introduction to Python for Data Science

Industry 4.0

Metal Cutting And Machine Tools

Solar Photovoltaics : Principles, Technologies & Materials

Introduction to Internet of Things

Introduction to Machine Learning

Python for Data Science

An Introduction to Artificial Intelligence

List of Core Foundation Course

Course Code	Course Name	L	T	P	C*
BVF 002	Environment Studies	2	0	0	2
BVF 013	Indian Cultural Heritage	2	0	0	2
BVF 017	Selected Writings of Great Authors - I	2	0	0	2
BVF 020	Women in Indian Society	2	0	0	2
BVF 015	Parenthood and Family Relation	2	0	0	2

List of Elective Foundation Course

Course Code	Course Name	L	T	P	C*
BVF 016	Science of Happiness	2	0	0	2
BVF 012	Human Body and Health	2	0	0	2
BVF 010	Design Thinking	2	0	0	2
BVF 019	Universal Human Values	2	0	0	2
BVF 018	Selected Writings of Great Authors - II	2	0	0	2

List of Vocational Courses

Course Code	Course Name	L	T	P	C*
VOC 011L	Basic Dress Making	0	0	4	2
VOC 005L	Dress Designing	0	0	4	2
VOC 014	Entrepreneurship - I	2	0	0	2
VOC 015	Entrepreneurship - II	2	0	0	2
VOC 020	Radio Production - I	2	0	0	2
VOC 021	Radio Production - II	2	0	0	2
VOC 022	Web Designing and Internet Technology-I	1	0	0	1
VOC 022L	Web Designing and Internet Technology-I Lab	0	0	2	1
VOC 023	Web Designing and Internet Technology-II	1	0	0	1
VOC 023L	Web Designing and Internet Technology-II Lab	0	0	2	1
VOC 009	Library Science - I	1	0	0	1
VOC 009L	Library Science – I Lab	0	0	2	1
VOC 010	Library Science – II	1	0	0	1
VOC 010L	Library Science – II Lab	0	0	2	1
VOC 018	Photography - I	0	0	4	2
VOC 019	Photography - II	0	0	4	2
VOC 016	Introduction to Artificial Intelligence - I	2	0	0	2
VOC 017	Introduction to Artificial Intelligence - II	2	0	0	2
VOC 012	Computer Assisted Learning and Teaching	1	0	0	1
VOC 012L	Computer Assisted Learning and Teaching Lab	0	0	2	1
VOC 013	Emerging Technologies for Learning and Teaching	2	0	0	2

Student can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester from Semesters III onwards with prior permission of respective heads and time table Permitting.

Every Student shall also opt for:
Five Fold Education: Physical Education I, Physical Education II,
Five Fold Education: Aesthetic Education I, Aesthetic Education II,
Five Fold Education: Practical Education I, Practical Education II
one each semester

* **L - Lecture hrs/week ; T - Tutorial hrs/week;**
P - Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C- Credit Points of the Course

Note: Syllabus of Foundation and Vocational courses are available in separate booklet, Curriculum Structure and Syllabus Foundation and Vocational Courses.

Curriculum Structure

Bachelor of Technology (Mechatronics Engineering)

First Year

Semester - I

Course Code	Course Name	L	T	P	C*
BVF 011/ BVF 014	General English / सामान्य हिन्दी	2	0	0	2
	Core Foundation Course - I	2	0	0	2
MATH 103/ MATH 107	Calculus/Linear Algebra	3	1	0	4
PHY 101/ PHY 106	Applied Optics/Modern Physics	3	1	0	4
CHEM 101/ BIO 101	Chemistry/Biology	3	1	0	4
CHE 102/ PHY 109	Thermodynamics/Engineering Mechanics	3	1	0	4
CS 109/ EEE 101	Computer Fundamentals and Programming/Electrical Engineering	4	0	0	4
CS 109L/ EEE 101L	Computer Fundamentals and Programming Lab /Electrical Engineering Lab	0	0	4	2
ENGG 101L/ ENGG 103 L	Engineering Drawing and Graphics Lab/ Measurement Techniques Lab	0	0	6	3
	Semester Total:	**20**	**4**	**10**	**29**

Semester - II

Course Code	Course Name	L	T	P	C*
BVF 014/ BVF 011	सामान्य हिन्दी / General English	2	0	0	2
	Core Foundation Course - II	2	0	0	2
MATH 107/ MATH 103	Linear Algebra/Calculus	3	1	0	4
PHY 106/ PHY 101	Modern Physics/Applied Optics	3	1	0	4
BIO 101/ CHEM 101	Biology/Chemistry	3	1	0	4
PHY 109/ CHE 102	Engineering Mechanics/Thermodynamics	3	1	0	4
EEE 101/ CS 109	Electrical Engineering / Computer Fundamentals and Programming	4	0	0	4
EEE 101L/ CS 109L	Electrical Engineering Lab/ Computer Fundamentals and Programming Lab	0	0	4	2
ENGG 103L/ ENGG 101L	Measurement Techniques Lab /Engineering Drawing and Graphics Lab	0	0	6	3
	Semester Total:	**20**	**4**	**10**	**29**

Second Year

Semester - III

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - III	2	0	0	2
	Elective Foundation Course - I	2	0	0	2
MATH 209/ MATH 210	Complex Variables/Differential Equations	3	1	0	4
ENGG 201/ ENGG 202	Structure and Properties of Materials/Basic Electronics	4	0	0	4
CS 209	Data Structures	4	0	0	4
CS 209L	Data Structures Lab	0	0	4	2
MCTR 201	Pneumatic Engineering	4	0	0	4
MCTR 201L	Pneumatic Engineering Lab	0	0	2	1
ELE 206	Digital Electronics	3	1	0	4
ELE 201L	Digital Electronics Lab	0	0	2	1
MCTR 202S	Seminar	0	0	2	1
	Semester Total:	**22**	**2**	**10**	**29**

Semester - IV

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - IV	2	0	0	2
	Elective Foundation Course - II	2	0	0	2
MATH 210/ MATH 209	Differential Equations/Complex Variables	3	1	0	4
ENGG 202/ ENGG 201	Basic Electronics/Structure and Properties of Materials	4	0	0	4
CS 214	Object Oriented Programming	4	0	0	4
CS 214L	Object Oriented Programming Lab	0	0	4	2
EIE 204	Electrical and Electronics Measurements	4	0	0	4
EIE 202L	Electrical and Electronics Measurements Lab	0	0	2	1
EEE 306	Electrical Machine-I	3	1	0	4
EEE 202L	Electrical Machine-I Lab	0	0	2	1
	Semester Total:	**22**	**2**	**8**	**28**

Third Year

Semester - V

Course Code	Course Name	L	T	P	C*
	Vocational Course - I	2	0	0	2
	Core Foundation Course - V/Elective Foundation Course - III	2	0	0	2
ECO 307/ MGMT 310	Fundamentals of Economics/Principles of Management	3	0	0	3
STAT 204/ MATH 311	Probability and Statistical Methods/Numerical Methods	3	1	0	4
ELE 311	Analog Integrated Circuits	3	1	0	4
ELE 301L	Analog Integrated Circuits Lab	0	0	2	1
EEE 307	Electrical Machine - II	3	1	0	4
EEE 301L	Electrical Machine - II Lab	0	0	2	1
EIE 308	Industrial Instrumentation	4	0	0	4
EIE 308L	Industrial Instrumentation Lab	0	0	2	1
EIE 309	Linear Control System	3	1	0	4
EIE 309L	Linear Control System Lab	0	0	2	1
Semester Total:		**23**	**4**	**8**	**31**

Semester - VI

Course Code	Course Name	L	T	P	C*
	Vocational Course - II	2	0	0	2
	Elective Foundation Course - III/Core Foundation Course - V	2	0	0	2
MGMT 310/ ECO 307	Principles of Management/ Fundamentals of Economics	3	0	0	3
MATH 311/ STAT 204	Numerical Methods/Probability and Statistical Methods	3	1	0	4
MCTR 305	Robotics and Control	4	0	0	4
MCTR 305L	Robotics and Control Lab	0	0	2	1
EIE 307	Industrial Automation	4	0	0	4
EIE 307L	Industrial Automation Lab	0	0	2	1
MCTR 304	Hydraulics Engineering	3	1	0	4
MCTR 304L	Hydraulics Engineering Lab	0	0	2	1
MCTR 302P	Project	0	0	4	2
	Semester Total:	**21**	**2**	**10**	**28**

Fourth Year

Semester - VII

Course Code	Course Name	L	T	P	C*
MCTR 425P	UIL Project	0	0	48	24
	Reading Elective	0	0	4	2
	Semester Total:	**0**	**0**	**52**	**26**

Semester - VIII

Course Code	Course Name	L	T	P	C*
EIE 310	Process Control	4	0	0	4
EIE 310L	Process Control Lab	0	0	2	1
MCTR 408	Computer Integrated Manufacturing System	4	0	0	4
MCTR 408L	Computer Integrated Manufacturing System Lab	0	0	2	1
MCTR 419	Mechatronics Systems	4	0	0	4
MCTR 419L	Mechatronics Systems Lab	0	0	4	2
ELE 509	Microprocessors and Microcontrollers	4	0	0	4
ELE 306L	Microprocessors and Microcontrollers Lab	0	0	2	1
	Discipline Elective	4	0	0	4
	Open Elective	4	0	0	4
	Semester Total:	**24**	**0**	**10**	**29**

List of Discipline Elective

Course Code	Course Name	L	T	P	C*
EEE 402	Energy Efficiency and Conservation	4	0	0	4
EIE 301	Biomedical Instrumentation	4	0	0	4
EIE 417	Power Plant Engineering	4	0	0	4
MCTR 420	Operation Research	4	0	0	4
MCTR 413	Industrial Engineering	4	0	0	4
MCTR 417	Manufacturing Science	4	0	0	4
MCTR 422	Production Technology	4	0	0	4
CS 401	Artificial Intelligence	4	0	0	4
IT 412	Internet of Things	4	0	0	4
CS 450	Machine Learning	4	0	0	4
CS 441	Computer Vision	4	0	0	4
CS 433	Soft Computing	4	0	0	4

List of Reading Electives
Fundamental of Semiconductor Devices
Principles of Signals and Systems
Advance power electronics and Control
Environmental Quality Monitoring & Analysis
Advance Power Electronics and Control
Electromagnetic Compatibility
Antennas
Introduction to Photonics
Transmission lines and electromagnetic waves
Biomedical signal processing
Embedded System Design With ARM
Introduction To Industry 4.0 And Industrial Internet Of Things
Mathematical methods and techniques in signal processing
Analog IC Design
Industrial Automation and Control
Non-Conventional Energy Resources
Deep Learning
Quality Design And Control
Interfacing with Arduino
Building Arduino robots and devices
Introduction to Python for Data Science
Industry 4.0
Metal Cutting And Machine Tools
Solar Photovoltaics : Principles, Technologies & Materials
Introduction to Internet of Things
Introduction to Machine Learning
Python for Data Science
An Introduction to Artificial Intelligence

List of Core Foundation Course

Course Code	Course Name	L	T	P	C*
BVF 002	Environment Studies	2	0	0	2
BVF 013	Indian Cultural Heritage	2	0	0	2
BVF 017	Selected Writings of Great Authors - I	2	0	0	2
BVF 020	Women in Indian Society	2	0	0	2
BVF 015	Parenthood and Family Relation	2	0	0	2

List of Elective Foundation Course

Course Code	Course Name	L	T	P	C*
BVF 016	Science of Happiness	2	0	0	2
BVF 012	Human Body and Health	2	0	0	2
BVF 010	Design Thinking	2	0	0	2
BVF 019	Universal Human Values	2	0	0	2
BVF 018	Selected Writings of Great Authors - II	2	0	0	2

List of Vocational Courses

Course Code	Course Name	L	T	P	C*
VOC 011L	Basic Dress Making	0	0	4	2
VOC 005L	Dress Designing	0	0	4	2
VOC 014	Entrepreneurship - I	2	0	0	2
VOC 015	Entrepreneurship - II	2	0	0	2
VOC 020	Radio Production - I	2	0	0	2
VOC 021	Radio Production - II	2	0	0	2
VOC 022	Web Designing and Internet Technology-I	1	0	0	1
VOC 022L	Web Designing and Internet Technology-I Lab	0	0	2	1
VOC 023	Web Designing and Internet Technology-II	1	0	0	1
VOC 023L	Web Designing and Internet Technology-II Lab	0	0	2	1
VOC 009	Library Science - I	1	0	0	1
VOC 009L	Library Science – I Lab	0	0	2	1
VOC 010	Library Science – II	1	0	0	1
VOC 010L	Library Science – II Lab	0	0	2	1
VOC 018	Photography - I	0	0	4	2
VOC 019	Photography - II	0	0	4	2
VOC 016	Introduction to Artificial Intelligence - I	2	0	0	2
VOC 017	Introduction to Artificial Intelligence - II	2	0	0	2
VOC 012	Computer Assisted Learning and Teaching	1	0	0	1
VOC 012L	Computer Assisted Learning and Teaching Lab	0	0	2	1
VOC 013	Emerging Technologies for Learning and Teaching	2	0	0	2

Student can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester from Semesters III onwards with prior permission of respective heads and time table Permitting.

Every Student shall also opt for:

Five Fold Education: Physical Education I, Physical Education II,

Five Fold Education: Aesthetic Education I, Aesthetic Education II,

Five Fold Education: Practical Education I, Practical Education II

one each semester

* **L - Lecture hrs/week ; T - Tutorial hrs/week;**
P - Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C- Credit Points of the Course

Note: Syllabus of Foundation and Vocational courses are available in separate booklet, Curriculum Structure and Syllabus Foundation and Vocational Courses.

Curriculum Structure

Bachelor of Technology (Electronics and Communication Engineering)

First Year

Semester - I

Course Code	Course Name	L	T	P	C*
BVF 011/ BVF 014	General English /सामान्य हिन्दी	2	0	0	2
	Core Foundation Course - I	2	0	0	2
MATH 103/ MATH 107	Calculus/ Linear Algebra	3	1	0	4
PHY 101/ PHY 106	Applied Optics/ Modern Physics	3	1	0	4
CHEM 101/ BIO 101	Chemistry/ Biology	3	1	0	4
CHE 102/ PHY 109	Thermodynamics/ Engineering Mechanics	3	1	0	4
CS 109/ EEE 101	Computer Fundamentals and Programming/ Electrical Engineering	4	0	0	4
CS 109L/ EEE 101L	Computer Fundamentals and Programming Lab/ Electrical Engineering Lab	0	0	4	2
ENGG 101L / ENGG 103L	Engineering Drawing and Graphics Lab/ Measurement Techniques Lab	0	0	6	3
	Semester Total:	**20**	**4**	**10**	**29**

Semester - II

Course Code	Course Name	L	T	P	C*
BVF 014/ BVF 011	सामान्य हिन्दी /General English	2	0	0	2
	Core Foundation Course – II	2	0	0	2
MATH 107 / MATH 103	Linear Algebra/ Calculus	3	1	0	4
PHY 106 / PHY 101	Modern Physics / Applied Optics	3	1	0	4
BIO 101/ CHEM 101	Biology / Chemistry	3	1	0	4
PHY 109 / CHE 102	Engineering Mechanics / Thermodynamics	3	1	0	4
EEE 101/ CS 109	Electrical Engineering / Computer Fundamentals and Programming	4	0	0	4
EEE 101L / CS 109L	Electrical Engineering Lab / Computer Fundamentals and Programming Lab	0	0	4	2
ENGG 103L / ENGG 101L	Measurement Techniques Lab / Engineering Drawing and Graphics Lab	0	0	6	3
	Semester Total:	**20**	**4**	**10**	**29**

Second Year

Semester - III

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - III	2	0	0	2
	Elective Foundation Course - I	2	0	0	2
MATH 210/ MATH 209	Differential Equations / Complex Variables	3	1	0	4
ENGG 202	Basic Electronics	4	0	0	4
CS 209	Data Structures	4	0	0	4
CS 209L	Data Structures Lab	0	0	4	2
ECE 201	Signals, Systems and Networks	4	0	0	4
ECE 201L	Signals, Systems and Networks Lab	0	0	2	1
ELE 206	Digital Electronics	3	1	0	4
ELE 201L	Digital Electronics Lab	0	0	2	1
ENGG 202L	Basic Electronics Lab*	0	0	2	1
	Semester Total:	**22**	**2**	**10**	**29**

Semester - IV

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - IV	2	0	0	2
	Elective Foundation Course - II	2	0	0	2
MATH 209/ MATH 210	Complex Variables / Differential Equations	3	1	0	4
ENGG 201	Structure and Properties of Materials	4	0	0	4
CS 214	Object Oriented Programming	4	0	0	4
CS 214L	Object Oriented Programming Lab	0	0	4	2
ECE 202S	Seminar	0	0	2	1
EIE 204	Electrical and Electronics Measurements	4	0	0	4
EIE 204L	Electrical and Electronics Measurements Lab	0	0	2	1
ELE 205	Semiconductor Devices and Circuits	4	0	0	4
ELE 205L	Semiconductor Devices and Circuits Lab	0	0	2	1
	Semester Total:	**23**	**1**	**10**	**29**

Third Year

Semester - V

Course Code	Course Name	L	T	P	C*
	Vocational Course - I	2	0	0	2
	Core Foundation Course-V / Elective Foundation Course - III	2	0	0	2
MGMT 310/ ECO 307	Principles of Management/Fundamentals of Economics	3	0	0	3
STAT 204/ MATH 311	Probability and Statistical Methods/ Numerical Methods	3	1	0	4
ECE 301	Analog Communication	4	0	0	4
ECE 301L	Analog Communication Lab	0	0	2	1
ELE 509	Microprocessors and Microcontrollers	4	0	0	4
ELE 306L	Microprocessor and Microcontrollers lab	0	0	2	1
ELE 310	Analog Electronics	4	0	0	4
ELE 310L	Analog Electronics Lab	0	0	2	1
ELE 202	Electromagnetic field Theory	4	0	0	4
	Semester Total:	**26**	**1**	**6**	**30**

Semester - VI

Course Code	Course Name	L	T	P	C*
	Vocational Course - II	2	0	0	2
	Elective Foundation Course - III/ Core Foundation Course - V	2	0	0	2
ECO 307/ MGMT 310	Fundamentals of Economics / Principles of Management	3	0	0	3
MATH 311/ STAT 204	Numerical Methods/Probability and Statistical Methods	3	1	0	4
ECE 305	Microwave Engineering	4	0	0	4
ECE 305L	Microwave Engineering Lab	0	0	2	1
EIE 311	Control Systems	4	0	0	4
EIE 302L	Control Systems Lab	0	0	2	1
ECE 304	Digital Communication	4	0	0	4
ECE 304L	Digital Communication Lab	0	0	2	1
ECE 306P	Project	0	0	4	2
	Semester Total:	**22**	**1**	**10**	**28**

Fourth Year

Semester - VII

Course Code	Course Name	L	T	P	C*
ECE 409	Antenna Analysis	4	0	0	4
ECE 409L	Antenna Analysis Lab	0	0	2	1
ECE 402	Fiber Optics and Communication	4	0	0	4
ECE 402L	Fiber Optics and Communication Lab	0	0	2	1
VLSI 401	VLSI Design	4	0	0	4
VLSI 402L	VLSI Design Lab	0	0	2	1
ECE 303	Communication Networks	4	0	0	4
	Discipline Elective	4	0	0	4
	Open Elective	4	0	0	4
	Semester Total:	**24**	**0**	**6**	**27**

Semester - VIII

Course Code	Course Name	L	T	P	C*
ECE 412P	UIL Project	0	0	48	24
	Reading Elective	0	0	4	2
	Semester Total:	**0**	**0**	**52**	**26**

List of Discipline Elective

Course Code	Course Name	L	T	P	C*
EIE 301	Biomedical Instrumentation	4	0	0	4
ECE 404	Optical Network	4	0	0	4
ECE 406	Satellite Communication	4	0	0	4
ELE 403	Basics of Nanoelectronics	4	0	0	4
ECE 403	Mobile Communication	4	0	0	4
ECE 405	Radar Navigation	4	0	0	4
ELE 410	Digital Signal Processing	3	1	0	4
RS 401	Geoinformatics	4	0	0	4
ECE 408	Analytical Instrumentation	4	0	0	4
ELE 402	Audio and Video Systems	4	0	0	4
MCTR 403	Robotics and Automation	4	0	0	4
EEE 308	Power Electronics	3	1	0	4
MCTR 402	Mechatronics	4	0	0	4

	List of Reading Electives	L	T	P	C*
ELE 413R	Electronic Packaging	0	0	4	2
ELE 416R	Multimedia Compression and Communication	0	0	4	2
ELE 417R	Professional Ethics	0	0	4	2
ELE 418R	Telecommunication Switching Systems and Networks	0	0	4	2

List of Online Reading Electives
Electric Vehicles
IoT Sensors and Devices
Electromagnetic Compatibility

List of Core Foundation Course

Course Code	Course Name	L	T	P	C*
BVF 002	Environment Studies	2	0	0	2
BVF 013	Indian Cultural Heritage	2	0	0	2
BVF 017	Selected Writings of Great Authors - I	2	0	0	2
BVF 020	Women in Indian Society	2	0	0	2
BVF 015	Parenthood and Family Relation	2	0	0	2

List of Elective Foundation Course

Course Code	Course Name	L	T	P	C*
BVF 016	Science of Happiness	2	0	0	2
BVF 012	Human Body and Health	2	0	0	2
BVF 010	Design Thinking	2	0	0	2
BVF 019	Universal Human Values	2	0	0	2
BVF 018	Selected Writings of Great Authors - II	2	0	0	2

List of Vocational Courses

Course Code	Course Name	L	T	P	C*
VOC 011L	Basic Dress Making	0	0	4	2
VOC 005L	Dress Designing	0	0	4	2
VOC 014	Entrepreneurship - I	2	0	0	2
VOC 015	Entrepreneurship - II	2	0	0	2
VOC 020	Radio Production - I	2	0	0	2
VOC 021	Radio Production - II	2	0	0	2
VOC 022	Web Designing and Internet Technology-I	1	0	0	1
VOC 022L	Web Designing and Internet Technology-I Lab	0	0	2	1
VOC 023	Web Designing and Internet Technology-II	1	0	0	1
VOC 023L	Web Designing and Internet Technology-II Lab	0	0	2	1
VOC 009	Library Science - I	1	0	0	1
VOC 009L	Library Science – I Lab	0	0	2	1
VOC 010	Library Science – II	1	0	0	1
VOC 010L	Library Science – II Lab	0	0	2	1
VOC 018	Photography - I	0	0	4	2
VOC 019	Photography - II	0	0	4	2
VOC 016	Introduction to Artificial Intelligence - I	2	0	0	2
VOC 017	Introduction to Artificial Intelligence - II	2	0	0	2

Course Code	Course Name	L	T	P	C*
VOC 012	Computer Assisted Learning and Teaching	1	0	0	1
VOC 012L	Computer Assisted Learning and Teaching Lab	0	0	2	1
VOC 013	Emerging Technologies for Learning and Teaching	2	0	0	2

Student can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester from Semesters III onwards with prior permission of respective heads and time table Permitting.

Every Student shall also opt for:
Five Fold Education: Physical Education I, Physical Education II,
Five Fold Education: Aesthetic Education I, Aesthetic Education II,
Five Fold Education: Practical Education I, Practical Education II
one each semester

* **L - Lecture hrs/week ; T - Tutorial hrs/week;**
P - Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C- Credit Points of the Course

Note: Syllabus of Foundation and Vocational courses are available in separate booklet, Curriculum Structure and Syllabus Foundation and Vocational Courses.

Project Evaluation Scheme

Duration	Course Code		Course Name	L	T	P	C
1 Semester (5 months) 1 Jul-30 Nov/ 1 Jan-31 May	ECE	412P	UIL Project	0	0	48	24
	EIE	419P	UIL Project	0	0	48	24
	EEE	412P	UIL Project	0	0	48	24
	MCTR	425P	UIL Project	0	0	48	24

Continuous Assessment (40 Marks)

1. Joining report, brief project outlay	- 10 Marks
2. Synopsis	- 10 Marks
3. Mid-term evaluation by Supervisor	- 10 Marks
4. Further evaluation by Supervisor	- 10 Marks
Total	**- 40 Marks**

End Semester Assessment (60 Marks)

1. Project Report	- 20 marks
2. Presentation	- 20 Marks
3. Viva-voce	- 20 Marks
Total	**- 60 Marks**

Five Fold Activities

Aesthetic Education I/II		Physical Education I/II	
BVFF 101	Classical Dance (Bharatnatyam)	BVFF 201	Aerobics
BVFF 102	Classical Dance (Kathak)	BVFF 202	Archery
BVFF 103	Classical Dance (Manipuri)	BVFF 203	Athletics
BVFF 104	Creative Art	BVFF 204	Badminton
BVFF 105	Folk Dance	BVFF 205	Basketball
BVFF 106	Music-Instrumental (Guitar)	BVFF 206	Cricket
BVFF 107	Music-Instrumental (Orchestra)	BVFF 207	Equestrian
BVFF 108	Music-Instrumental (Sarod)	BVFF 208	Flying - Flight Radio Telephone Operator's Licence (Restricted)
BVFF 109	Music-Instrumental (Sitar)	BVFF 209	Flying - Student Pilot's Licence
BVFF 110	Music-Instrumental (Tabla)	BVFF 229	Aeromodelling
BVFF 111	Music-Instrumental (Violin)	BVFF 210	Football
BVFF 112	Music-Vocal	BVFF 211	Gymnastics
BVFF 113	Theatre	BVFF 212	Handball
Practical Education I/II		BVFF 213	Hockey
BVFF 301	Banasthali Sewa Dal	BVFF 214	Judo
BVFF 302	Extension Programs for Women Empowerment	BVFF 215	Kabaddi
BVFF 303	FM Radio	BVFF 216	Karate - Do
BVFF 304	Informal Education	BVFF 217	Kho-Kho
BVFF 305	National Service Scheme	BVFF 218	Net Ball
BVFF 306	National Cadet Corps	BVFF 219	Rope Mallakhamb
		BVFF 220	Shooting
		BVFF 221	Soft Ball
		BVFF 222	Swimming
		BVFF 223	Table Tennis
		BVFF 224	Tennis
		BVFF 225	Throwball
		BVFF 226	Volleyball
		BVFF 227	Weight Training
		BVFF 228	Yoga

Every Student shall also opt for:
Five Fold Education: Physical Education I, Physical Education II,
Five Fold Education: Aesthetic Education I, Aesthetic Education II,
Five Fold Education: Practical Education I, Practical Education II
one each semester

Evaluation Scheme and Grading System

Continuous Assessment (CA) (Max. Marks)					End-Semester Assessment (ESA) (Max. Marks)	Grand Total (Max. Marks)
Assignment		Periodical Test		Total (CA)		
I	II	I	II			
10	10	10	10	40	60	100

In all theory, laboratory and other non classroom activities (project, dissertation, seminar, etc.), the Continuous and End-semester assessment will be of 40 and 60 marks respectively. However, for Reading Elective, only End semester exam of 100 marks will be held. Wherever desired, the detailed breakup of continuous assessment marks (40), for project, practical, dissertation, seminar, etc shall be announced by respective departments in respective student handouts.

Based on the cumulative performance in the continuous and end-semester assessments, the grade obtained by the student in each course shall be awarded. The classification of grades is as under:

Letter Grade	Grade Point	Narration
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C+	5	Average
C	4	Below Average
D	3	Marginal
E	2	Exposed
NC	0	Not Cleared

Based on the obtained grades, the Semester Grade Point Average shall be computed as under:

$$SGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ---- + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ---- + CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of courses (with letter grading) registered in the semester, CC_i are the course credits attached to the i^{th} course with letter grading and GP_i is the letter grade point obtained in the i^{th} course. The courses which are given Non-Letter Grades are not considered in the calculation of SGPA.

The Cumulative Grade Point Average (CGPA) at the end of each semester shall be computed as under:

$$CGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ----+ CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ----+ CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of all the courses (with letter grading) that a student has taken up to the previous semester.

Student shall be required to maintain a minimum of 4.00 CGPA at the end of each semester. If a student's CGPA remains below 4.00 in two consecutive semesters, then the student will be placed under probation and the case will be referred to Academic Performance Review Committee (APRC) which will decide the course load of the student for successive semester till the student comes out of the probationary clause.

To clear a course of a degree program, a student should obtain letter grade C and above. However, D/E grade in two/one of the courses throughout the UG/PG degree program respectively shall be deemed to have cleared the respective course(s). The excess of two/one D/E course(s) in UG/PG degree program shall become the backlog course(s) and the student will be required to repeat and clear them in successive semester(s) by obtaining grade C or above.

After successfully clearing all the courses of the degree program, the student shall be awarded division as per following table.

Division	CGPA
Distinction	7.50 and above
First Division	6.00 to 7.49
Second Division	5.00 to 5.99
Pass	4.00 to 4.99

CGPA to % Conversion Formula: % of Marks Obtained = CGPA * 10

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Detailed Syllabus

MATH 103 Calculus

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	3	1	0	4

Learning Outcomes:

After successful completion of the course, students will be able to:

- Define limit, infinite series and sequence of partial sums of an infinite series, Convergence and Divergence of an infinite series.
- Relate the limit of a function at a point to the limit of a sequence at that point and tell when a function will fail to have a limit at a point.
- Define monotonic functions and find a connection between monotonicity of a function and derivative of a function.
- Demonstrate the concept of Divergence, Curl, Green's theorem, Stokes's theorem.

Section A

Sequences, series, test for convergence, power series, radius of convergence; limit, continuity and differentiability (analytic definitions with simple examples); Rolle's Theorem, mean value theorem and Taylor's theorem; Successive differentiation: Leibnitz' theorem (without proof).

Section B

Review of vectors, Cylinders and quadric surfaces, Vector functions of one variable and their derivatives, Partial derivatives: Chain rule, exact differentials, Gradient, Directional derivative, Tangent planes and normals, Maxima and minima (two variables) including Lagrange's multipliers, Asymptotes and Curve tracing.

Section C

Riemann integral and the fundamental theorem of integral calculus, Reduction Formulae, Multiple integrals, Applications to multiple integrals to find length, area, surface area, volume, surface area of revolution, Improper integral.

Vector fields, Surface integral, Line integral, Independence of path, Conservative fields, Divergence, Curl, Green's theorem, Stokes's theorem.

Suggested Books:

1. Thomas, G.B., Weir, M.D., & Hass, J. (2011). *Thomas' Calculus* (11th ed.).Boston, MA: Pearson Education, Inc.
2. Kreyszig, E. (2011). *Advanced Engineering Mathematics* (9th ed.). Hoboken, NJ : John Wiley & Sons, Inc.
3. Apostol, T.M. (1980). *Calculus* (2nded.). New York, NY: John Wiley & Sons, Inc.
4. Grewal, B.S., & Grewal, J.S. (2012). Higher Engineering Mathematics (42thed.). India, Delhi: Khanna Publishers.

Suggested E-learning material:

1. Differentiation and Integration of Vector Functions

   http://vle.du.ac.in/pluginfile.php/837/mod_resource/content/0/Differentiation%20and%20Integration%20of%20Vector%20Functions.pdf
2. Mean Value Theorems

   http://vle.du.ac.in/pluginfile.php/844/mod_resource/content/0/Mean%20Value%20Theorems.pdf
3. Infinite Series

   http://vle.du.ac.in/pluginfile.php/861/mod_resource/content/0/Infinite%20Series.pdf

MATH 107 Linear Algebra

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students will be able to:

- Define basic terms and concepts of matrices, vectors and complex numbers
- Use basic vector space concepts such as linear space, linear dependence, basis, dimension, linear transformation;
- Be familiar with the concepts of eigenvalue, eigenspace and eigenvector and know how to compute these objects;
- Use the characteristic polynomial to compute the eigenvalues and eigenvectors of a square matrix and use them to diagonalise matrices

when this is possible; discriminate between 53iagonalizable and non-diagonalisable matrices.

- Use gauss-jordan elimination to solve systems of linear equations and to compute the inverse of an invertible matrix

Section A

Vectors, Algebra of vectors, vector spaces, subspaces, Linear sum and direct sum of subspaces, Linear combination, Linear span, Linear dependence and independence of vectors and its properties. Basis and dimension of vector space and subspace. Linear mappings, Kernel and Range of linear mapping, Singular and non-singular mappings.

Section B

Linear operator, Algebra of linear operators, Invertible operators, Matrix representation of a linear transformation, Change of basis, Range, rank and Kernel, nullity of a matrix, Elementary transformations, Matrix inversion with elementary transformations, Normal form of a matrix, System of linear equations.

Section C

Characteristics polynomial of a matrix, Characteristics values, Characteristics vector, Cayley-Hamilton theorem, Diagonalization of Matrices, Properties of characteristic values and characteristic vectors of Hermitian, skew-Hermitian, Unitary and Normal matrices (including Symmetric, Skew-symmetric and Orthogonal matrices).

Inner product spaces, Orthogonality, Orthogonal sets and bases, Gram-Schmidt orthogonalization process.

Suggested Books:

1. Axler, S. J. (1996*). Linear algebra done right*. New York: Springer.
2. Krishnamurthy, V., Mainra, V. P., & Arora, J. L. (1976). *An introduction to linear algebra*. New Delhi: East-West Press.
3. Friedberg, S. H., Insel, A. J., Spence, L. E., & Thiel, L. (2017). *Linear algebra*. Pearson Education.
4. Halmos, P. R. (2013). *Linear Algebra Problem Book*. Cambridge: Cambridge University Press.
5. Kumaresan, S. (2000). *Linear Algebra: A Geometric Approach*. New Delhi: Prentice-Hall (India).

Suggested E-learning material:

1. Lecture notes on linear Algebra
   https://nptel.ac.in/downloads/111102011/
2. Videos on Linear Algebra topics
   http://web.mit.edu/18.06/www/videos.shtml

PHY 101 Applied Optics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcome:

After completion of the course students will be able to:

- Appreciate the efficacy of Fourier transforms and their application to physical systems.
- Understand linear, time-invariant systems.
- Understand the role of the wave equation and appreciate the universal nature of wave motion in a range of physical systems
- Understand dispersion in waves and model dispersion using Fourier theory.
- Understand diffraction and imaging in terms of Fourier optics and gain physical and intuitive insight in a range of ph

Section A

Wave Optics- Interference: Superposition of Waves, Theory and method of measurement of wavelength of light and thickness of a thin transparent plate using Fresnel's Bi-prism, Interference in thin films, Newton's rings, Michelson's Interferometer,

Diffraction I: Fraunhofer's diffraction due to single slit, two parallel slits and N slits.

Section B

Diffraction II: Diffraction by plane transmission Grating (PTG), Characteristics of Grating Spectra, Measurement of Wavelength of light

using PTG, Concept of resolving power, Rayleigh's criterion of resolving limit, Resolving power of a Grating, Diffraction of X-rays and Bragg's law.

Polarization: Production and detection of plane, Circularly and elliptically polarized light, theory of the polarized light, Optical Activity, Fresnel's Explanation for optical rotation, Measurement of Specific rotation of a cane sugar solution using a Half Shade and a biquartz device polarimeter.

Section C

Modern Optics-Lasers : Spontaneous & Stimulates Emission, Einstein's Coefficient, Criterion of Laser action, Ruby and He-Ne Lasers, Characteristics of Laser light, Application of Laser with special emphasis on Holography.

Optical Fiber: Elementary idea of optical fiber, Light wave communication using optical fibers, Types of optical fibers, Step Index (Single mode and Multi mode) and Graded Index fiber, Light Propagation through optical fiber,

Ray Optics: Critical angle, Total internal reflection, Aceptance angle, Numerical aperture of an optical fiber.

Suggested Readings:

1. Prakash S., Verma A. S., Gupta S. K. and Alvi P. A. (2015) A textbook of Optics and Modern Physics, Pragati Prakashan Meerut.
2. Allen S. R. (1997) An introduction to Fiber Optics, PHI
3. Seth S. P. (2007) Elements of Electromagnetic Field, Dhanpat Rai & Company.
4. Ghatak A. (2005) Optics, Tata McGraw hill publication
5. Beynon (1996) Introductory University optics, Prentice Hall of India Pvt. Ltd.
6. Thyagarajan and Ghatak (1981) Lasers Theory and Applications: Macmillan India Ltd
7. Senior John M. (2005) An introduction to Fiber Optics, PHI
8. Sadiku M. N. O (2007) Elements of Electromagnetics, Oxford University Press.

Suggested E-Learning Materials:

1. https://nptel.ac.in/course.php

PHY 106 Modern Physics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcome:

After completion of the course students will be able to:

- Development of an understanding of the interrelationships of science, eengineering and technology.
- Will have skill for problem solving and engineering skills, which then has broad applications.
- Will have a career paths for Engineering physics are usually (broadly) "engineering, applied science or applied physics through research, teaching or entrepreneurial engineering". This interdisciplinary knowledge is designed for the continuous innovation occurring with technology.
- Will have strong ground to provide a more thorough grounding in applied physics of any area chosen by the student (such as nanotechnology, mechanical engineering, electrical engineering, control theory, aerodynamics, or solid-state physics).

Section A

Special Theory of Relativity: Inertial and non-inertial frames of reference, postulates of special theory of relativity, Lorentz Transformations, Relativity of mass, length, time and velocity, Mass energy relation, energy momentum relation;

Wave Mechanics: Compton effect as evidence of quantum nature of radiation, Heisenberg's uncertainty principle, Time dependent & Time independent (Steady State) form of the Schrödinger equation, Solution of Schrodinger equation for free particle in a one dimension box and Potential step.

Section B

Free-electron model of metals, Origin of Bands in solids (Kronig-Penny model), E-k diagram, classification of solids as metal, semiconductors and insulators, Density of energy states and Fermi energy, Crystal structures of Si, Ge and GaAs, Electrical resistivity of semiconductors.

Superconductivity: Introduction, Types of superconductors, Properties of superconductors, Meisner effect, Joshephson effect, BCS theory of superconductivity (no derivation) only qualitative discussion, High Temperature superconductors, Applications of superconductors.

Section C

Dielectric Materials: Dielectric Constant, Type of Dielectrics, Polarization of Dielectrics, Polarization density, Relation between dielectric constant and electric susceptibility, Types of Polarization (Electronic polarization, ionic polarization, orientation polarization), Clausius-Mosotti Equation, **Nuclear Physics**: Nuclear Binding Energy, Fission and Fusion Reactions, Construction, theory and applications of Geiger Muller Counter , Proportional and Scintillation Counter.

Suggested Books:

1. Beiser, A. (2003). Concepts of modern physics. Tata McGraw-Hill Education.
2. Krane, K. S. (1995). Modern physics. Modern Physics, 2nd Edition, by Kenneth S. Krane,. ISBN 0-471-82872-6. Wiley-VCH, August 1995.,
3. Birkhoff, G. D., & Langer, R. E. (1923). Relativity and modern physics. Harvard University Press.
4. Leighton, R. B., & Leighton, R. B. (1959). Principles of modern physics (Vol. 795). New York: McGraw-Hill.
5. Prakash S., Verma A. S., Gupta S. K. and Alvi P. A. (2015) A textbook of Optics and Modern Physics, Pragati Prakashan Meerut
6. Raghuvanshi (2008) Engineering Physics, Tata Mc Hill

Suggested E-Learning Materials:

1. https://nptel.ac.in/course.php

CHEM 101 Chemistry

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcome:

On completion of course, the students will be able to:

- Explain the basics of atomic structure and chemical bonding.

- Explain the behavior of the system through phase, degree of freedom and component.
- Explain the basics of electrochemistry, different type of corrosion and their prevention.
- Differentiate nanoscience, nanotechnology, nanochemistry, conventional and non-conventional energy sources and their applications.

Section A

Atomic Structure: Introduction, Schrodinger wave equation, significance of Ψ and Ψ^2, quantum numbers, radial and angular wave function , probability distribution curves, shapes of *s, p, d* orbitals. Aufbau and Pauli principles, Hund's multiplicity rule, fiiling of electron upto 71 elements, exchange energy, pairing energy, symmetrical distribution of charge, extra stability of half-filled and completely-filled orbitals, Slater's rules for evaluation of shielding constant and effective nuclear charge.

Covalent bond: Introduction, Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, valence shell electron pair repulsion (VSEPR) theory with reference to $BeCl_2$, $SnCl_2$, BF_3, BF_4^-, NH_3, H_2O, H_3O^+, PCl_5, SF_4, CIF_3, I_3^-, SF_6, IF_7, ICI_2^-, and $POCl_3$; MO theory, sigma and pi Molecular orbitals theory, homonuclear and heteronuclear (CO, NO) diatomic molecules and their ions.

Section B

Electrochemistry: Electric transport in electrolytic solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution, migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its uses and limitations, Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only), applications of conductivity measurement: determination of degree of dissociation, determination of K_a of acids, determination of solubility product of sparingly soluble salt, conductometric titrations.

Phase Rule: Phase, component, degree of freedom or variance; phase diagram of one-component system: -water system, sulphur system, CO_2 system, phase rule for two-component system: reduced phase rule, eutectic point., Pb-Ag system and its applications.

Corrosion: Definition, types (Dry, Wet, Pitting, Stressed, Galvanic Cell, Water Line and Concentration Cell Corrosion), its significance, Mechanisms of corrosion, Protection from corrosion: Protective coatings, Cathodic protection, sacrificial anode and Modification in designs etc.

Section C

Water: Hardness, types of Hardness, Degree of hardness, determination of hardness by Clark's test and Complex metric (EDTA) method, degree of hardness, numerical based on EDTA and Clark's method, Boiler troubles their causes, disadvantages and prevention, Formation of solids (Scale and Sludge), Carry over (Priming and Foaming), Corrosion and Caustic Embrittlement, Advanced methods of water starelization, Softening of water by Lime-Soda Method, Permutit (Zeolite) Method and Deionization or Demineralization Method, Numerical problems based on Lime-Soda and Zeolite softening methods

Organic Electronic Materials: Introduction**,** classification, factor affecting the conductivity of polymers, Applications.

Optical fires: Introduction, properties, preparation, optical fiber grade glass and uses.

Non-conventional energy: Introduction of solar energy, Application of solar energy, Photovoltaic cell, conversion of solar energy, Biofuel and biomass, Superiority of non-conventional source of energy over conventional energy.

Recommended Books:

1. B.R. Puri and L.R. Sharma & K.C. Kalia (2017), *Principles of Inorganic Chemistry*, 33rd Ed.,Vishal **Publications**.
2. L.R Sharma, M.S Pathania B.R Puri and Navjot Kaur (2018), A Textbook of Physical Chemistry, Vishal **Publications**.
3. W. U. Malik, G.D.Tuli & R. D. Madan (2010), *Selected Topics in Inorganic Chemistry*, Revised Ed., S. Chand Publications.
4. Gurdeep Raj(2014), Advanced Physical Chemistry, goel publications.
5. J.D. Lee (1998), *Concise Inorganic Chemistry*,5th Ed, Oxford Publications.
6. F. A. Cotton and G. Wilkinson (1994), *Basic Inorganic Chemistry*,3rd Ed., John Wiley Publications**.**
7. P. Bhagchandani (2017), *Inorganic* Chemistry, Sahitya Bhawan Publications.
8. S.S. Dara and S.S.Umare (2004), Textbook of Engineering Chemistry, S. Chand Publications.

Suggested e-Sources:

1. National Programme on Technology Enhanced Learning
   https://nptel.ac.in

2. Online Chemistry Courses
   https://www.edx.org/learn/chemistry
3. Free Online Education SWAYAM
   https://swayam.gov.in

BIO 101 Biology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand the basic organization and classification of living organisms.
- Gain broad understanding of cellular functions.
- Understand the fundamental concepts of molecular biology and recombinant DNA technology.

Section A

- Brief idea of origin of life, Viruses (TMV, HIV, Bacteriophages), overview and brief introduction to five kingdom classification, characteristic features of Protista, Plantae and Animalia.
- Morphology and functions of different parts of flowering plants: Root, stem, leaf, major inflorescence (Spike, Raceme, Corymb and Umbel), flower, fruit and seed.
- Brief about the components and functions of different systems of humans.

Section B

- The cell concept, prokaryotic (Bacteria, cell structure) and eukaryotic cell (plant and animal cell). Cell organelles and their functions.
- Brief introduction and significance of carbohydrates, lipids, proteins and enzymes.
- Mendelian inheritance chromosome theory of inheritance, deviations from mendelian ratio (Incomplete dominance, co-dominance,

complementary genes, multiple alleles). Linkage and crossing over, sex determination, sex linked inheritance, genetic counseling.

Section C

- Structure and replication of DNA, structure of RNA and brief concept of transcription and translation in prokaryotes and comparison with eukaryotes, Genetic code, Basic concept of recombinant DNA Technology and its applications. Overview of Human Genome Project, Biosafety issues.

Suggested Books:

- Green, N. P. O., Stout, G. W., Taylor, D. J. & Soper, R. (2005). *Biological Sciences*. Cambridge University Press.
- Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Jackson, R.B. (2013). *Campbell Biology*. Pearson Publisher, India.

Suggested e-Resources:

- **Structural organization of plants and animals** https://www.emedicalprep.com/study-material/biology/structural-organization-in-plants-and-animals/
- **Morphology, anatomy and functions of different systems of humans:**

  https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-body-structure-and-homeostasis/a/tissues-organs-organ-systems
- **Basic concept of cell**

  https://biologydictionary.net/cell/
- **Gene-gene interaction**

  http://www.biologydiscussion.com/genetics/gene-interactions/gene-interactions-allelic-and-non-allelic-cell-biology/38795
- **Human genome project**

  https://www.genome.gov/12011238/an-overview-of-the-human-genome-project/
- **Application of recombinant DNA technology:**

  https://medcraveonline.com/JABB/JABB-01-00013

CHE 102 Thermodynamics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning outcomes:

The students will be able to:

- Carryout thermodynamic analysis of real systems.
- Carryout thermodynamic analysis multiphase systems with chemical changes.
- Understand thermodynamic functions and their relationships

Section A

Definition, significance and limitations, Classical versus statistical thermodynamics, definition of thermodynamic terms: system, surroundings etc., types of systems, intensive and extensive properties, state and path functions and their differentials, Euler reciprocity relation and cyclic rule, thermodynamic process, concept of heat and work.

First law of thermodynamics: statement, definition of internal energy and enthalpy, heat capacity-heat capacities at constant volume and pressure and their relationship, Bomb calorimeter, Joule's Law, Joule-Thomson coefficient and inversion temperature, calculation of w, q, ΔU & ΔH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process, application of first law of thermodynamics in closed systems, zeroth law of thermodynamics and the absolute temperature scale.

Section B

Thermochemistry: Heat of reaction at constant pressure and at constant volume, Hess's law of heat summation and its application, temperature dependence of enthalpy (Kirchhoff's equation), bond dissociation energy and its calculation from thermo-chemical data,

Second law of Thermodynamics: need for the law, different statements of the law, Carnot cycle and its efficiency, Carnot theorem, Heat Engine, Efficiencies, thermodynamic scale of temperature.

Concept of Entropy: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium, entropy change in ideal gases and mixing of gases.

Section C

Thermodynamic Relations: Maxwell's equations, TdS equations, difference in heat capacities, ratio of heat capacities, energy equations, Joule-Kelvin effect, Clausius-Clapeyron equation.

Third law of Thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data, Gibb's and Helmholtz functions: Gibbs-Helmholtz equation, Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, variation of G and A with P, V and T.

Recommended Books:

1. Atkins, P. W., & De, P. J. (2006). Atkins' physical chemistry. Oxford: Oxford University Press.
2. Puri, S., Sharma, R. L., & Pathania M. S. (2004). Principles of physical chemistry. Vishal Publishing Co.
3. Sharma, K. K., & Sharma, L. K. (1977). A textbook of physical chemistry. Vikas Publishing House.
4. P. K. Nag (2009). Basic & applied thermodynamics. Tata McGraw Hill.
5. Van Ness, H. C. (1983). Understanding thermodynamics. Courier Corporation.
6. Van Wylen, G. J., & Sonntag, R. E. (1985). Fundamentals of classical thermodynamics. New York: Wiley.

E-resource(s): https://nptel.ac.in

PHY 109 Engineering Mechanics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcome:

After completion of the course students will be able to:

- Students will demonstrate proficiency in mathematics and the mathematical concepts needed for a proper understanding of physics.

- Students will show that they have learned laboratory skills, enabling them to take measurements in a physics laboratory and analyze the measurements to draw valid conclusions.
- Students will be capable of oral and written scientific communication, and will prove that they can think critically and work independently

Section A

System of forces, Fundamental laws of mechanics, Composition of forces, Free body diagram, Lami's theorem, Moments and couple, Varignon's theorem, Condition of equilibrium, Types of support and loading, Reaction, Analysis of simple trusses by methods of joints and methods of sections. The laws of Coulomb friction, Ladder, wedges, Belt friction and rolling, Principle of virtual work and its applications.

Section B

Location of centroid and center of gravity, area moment of inertia, mass moment of inertia law of mechanics, Variation of mechanical advantages, efficiency, reversibility of machine Pulleys, wheel and axle, wheel and differential axle, Transmission of power through a belt and rope, Moment of inertia of masses- Transfer formula for mass moments of inertia- Mass moment of inertia of composite bodies.

Section C

Kinematics of a Particle: Rectilinear motion, plane curvilinear motion, Projectile motion, Constrained motion of connected particles.

Dynamics of Particles and Rigid Body: Newton's Law of motion, D'Alembert's principle.

Work & energy: Work, Energy (Potential, kinetic and spring), Work-Energy relation, Law of conservation of energy,

Impulse & momentum: Impulse, momentum, Impulse-momentum relation, Impact

Vibration: Definitions, Concepts- simple harmonic motion-free vibrations-simple and compound pendulums-torsional vibrations.

Suggested Books:

1. Kumar D. S. (2009) Engineering Mechanics, Laxmi Publication
2. Dubey N. H (2015) Engineering Mechanics, McGraw Hill Edu
3. Sharma M. (2009) Engineering Mechanics, CBH

4. Sharma (2009) Mechanics, Pearson

Suggested Web Resources:

1. https://nptel.ac.in/course.php

CS 109 Computer Fundamentals and Programming

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students will be able to:

- Describe the concepts of computer basics and programming.
- Explain the organization and operations of a computer system.
- Design the combinational and sequential circuits.
- Employ the logical thinking for analyzing problems, designing and implementing algorithmic solutions.
- Employ the skills for the use of the C programming language to implement the real world applications.

Section A

Brief introduction to computer organization, Block diagram, Hardware and software. Introduction to operating System, Concept of Data and Information, Representation of data, bits and bytes, Number System (binary, octal, decimal, hexadecimal), Representation of integers, real numbers, positive and negative numbers, Binary arithmetic, simple concepts and theorems of Boolean algebra. Representation of characters: BCD, ASCII, EBCDIC codes. Programming fundamentals: Program, Steps in program development, programming language, compilers, interpreters. Algorithms, flowcharts, Control statements sequencing, conditional and unconditional branching and looping.

Section B

Overview of C language- History, structure of a program data types, variables, constants, operators (arithmetic, logical, relational), expressions (arithmetic and logical), assignments, conditional statements, control

statements, simple I/O. Single and multi-dimensional arrays, Searching (linear, binary), sorting (bubble, selection) and merging, matrix arithmetic.

Section C

Concept of pointers, pointer expression, pointer v/s arrays, functions, parameter passing (call by value, call by reference), recursion, structure, union and enumerated data types, concept of structured programming.

Suggested Books:

1. Sinha, P. K. (2003). *Computer fundamentals: concepts, systems & applications*. BPB publications.
2. Balagurusamy, E. (2012). *Programming in ANSI C*. Tata McGraw-Hill Education.
3. Kanetkar, Y. P. (2016). *Let us C*. BPB publications.
4. Rajaraman, V., & ADABALA, N. (2014). *Fundamentals of computers*. PHI Learning Pvt. Ltd.

Suggested E-learning material:

1. Introduction to Programming in C
   https://nptel.ac.in/courses/106104128/
2. Introduction to Programming in C Specialization
   https://www.coursera.org/specializations/c-programming
3. Sinha, P. K. (2003). Computer fundamentals: concepts, systems & applications. BPB publications.
   https://www.edutechlearners.com/computer-fundamentals-p-k-sinha-free-pdf/

CS 109L Computer Fundamentals and Programming Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students will be able to:

- Perform internal and external DOS commands.

- Implement problems based on expressions containing constants, variables and operators.
- Implement problems based on conditional statements, switch and loops.
- Implement problems based on array, pointers, functions, files and command line arguments.

Lab Exercise

1. Explore DOS & WINDOWS Operating System
2. Implement Following programs in 'C'

I. Simple Programs

i. Arithmetic Calculation

ii. Formula Based Calculation

II. Conditional Statements

i. Check odd-even, positive-negative

ii. Calculation of Division, Rank of student

iii. Solution of Quadratic Equations

iv. Menu Driven Programs

v. Programs using if and switch statement

III. Looping

i. Sum of digits of number, reverse of number, palindrome checking

ii. Table Generation

iii. Prime number checking, generation

iv. Calculation of GCD, LCM

v. Sum of various series, Fibonacci series, sin, cos, exp etc.

vi. Pattern Drawing

IV. Programming with Arrays

i. Max, min & Average calculation

ii. Linear Search

iii. Binary Search

iv. Bubble Sort

v. Selection Sort

vi. Merging

vii. Number System Conversion

viii. Matrix Manipulation- sum of row, column & diagonal element

ix. Display and sum of upper triangular, lower triangular matrix elements

x. Matrix Arithmetic (Addition, Subtraction, Multiplication)

xi. String Manipulation

V. Pointers and Functions

i. Use of Functions the previous programs

ii. Use of pointers and function in array and string processing

iii. Recursion-factorial, GCD, Fibonacci, Power, Tower of Hanoi etc.

VI. Structures

i. Operations on Complex number

ii. Record storage, searching, sorting, generating reports

iii. Use of Union

EEE 101 Electrical Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Understand the importance of electrical engineering
- Solve complex DC circuits
- Solve& predict the behavior of AC circuit

- Understand different machines along with measurement techniques
- Select appropriate element, device or machines with respect to application

Section A

DC Networks: Node Voltage and Mesh Current Analysis; Source Conversion. Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power Transform, Laplace transforms and inverse Laplace transforms: Basic Theorem and Circuit analysis using Laplace transformations, Initial and final value theorem.

Section B

Single Phase AC Circuits: EMF Equation, Average, RMS and Effective Values. RLC Series, Parallel and Series, Parallel Circuits, Complex Representation of Impedances. Phasor Diagram, Power and Power Factor.

Three Phase A.C. Circuits: Delta-Star and Star-Delta Transformation, Line & Phase Quantities, 3-Phase Balanced Circuits, Phasor diagram, Measurement of Power in Three Phase Balanced Circuits.

Section C

Transformer: Magnetic coupled circuits, Dot convention for coupled circuits, coefficient of coupling, mutual inductance, EMF Equation, Voltage & Current, Relationship and Phasor Diagram of Ideal Transformer.

Introduction to principle of DC Machines, synchronous machines and induction motors.

Text Books

1. Toro, V. D. (1989). *Electrical Engineering Fundamentals* (2nd ed.). PHI Publication.
2. Bobrow, L. S. (1996). *Fundamental of Electrical Engineering*(2nd ed.). Oxford Publication.
3. Nagrath,J. &Kothari,D.P. (2017).*Basic Electrical Engineering*(3rd ed.).India: TMH.
4. Sahdev,S. K. (2015). *Basic Electrical Engineering*. India: PearsonEducation India.

Reference Books

1. Chakrabarti,A.K. (2018). *Circuit Theory* (7th ed.). Dhanpat Rai and Co.

2. Alaxender, C. &Sadiku, M. N. O. (2003). *Fundamentals of Electrical circuits.* Oxford University Press.
3. Choudhary, D. R. (2013). *Networks and Systems.* Wiley Eastern Ltd.
4. Hayt, W. H., Kemmerly, J.&Durbin,S. M. (2013). *Engineering Circuit analysis*(8th ed.).Tata Mc Graw Hill.
5. Valkenburg, M.E.V.(2006). *Network Analysis*. New Delhi: Prentice Hall.

E-Resources:

1. https://nptel.ac.in/courses/108108076/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/
3. https://swayam.gov.in/electrical/c/4/engineering
4. https://swayam.gov.in/courses/4746-july-2018-fundamentals-of-electrical-engineering
5. https://nptel.ac.in/courses/108105053/pdf/L-03(GDR)(ET)%20((EE)NPTEL).pdf
6. https://nptel.ac.in/courses/108105053/pdf/L-04(GDR)(ET)%20((EE)NPTEL).pdf
7. https://nptel.ac.in/courses/108105053/pdf/L-06(GDR)(ET)%20((EE)NPTEL).pdf
8. https://nptel.ac.in/courses/108105053/pdf/L-07(GDR)(ET)%20((EE)NPTEL).pdf
9. https://nptel.ac.in/courses/108105053/pdf/L-08(GDR)(ET)%20((EE)NPTEL).pdf
10. https://nptel.ac.in/courses/108105053/pdf/L-14(NKD)(ET)%20((EE)NPTEL).pdf
11. https://nptel.ac.in/courses/108105053/pdf/L-15(NKD)(ET)%20((EE)NPTEL).pdf
12. https://nptel.ac.in/courses/108105053/pdf/L-17(NKD)(ET)%20((EE)NPTEL).pdf
13. https://nptel.ac.in/courses/108105053/pdf/L23(TB)(ET)%20((EE)NPTEL).pdf
14. https://www.scribd.com/doc/123459017/basic-electrical engineering?campaign=SkimbitLtd&ad_group=725X1342X724adc86f

b3fde3cdc1f294ab4f382ea&keyword=660149026&source=hp_affiliate&medium=affiliate

EEE 101L Electrical Engineering Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes

The Students will be able to:

- Handle measuring instruments and apparatus
- Identify the various electrical and electronic components as per the ratings
- Verify circuit laws and solve electrical networks
- Analyze the characteristics of semiconductor devices
- Design basic AC & DC circuits

LIST OF EXPERIMENTS

1. Study of electronic components and apparatus.
2. Study ofdigital& analog Multimeter.
3. Study of Cathode Ray Oscilloscope (CRO)
4. Verification of principle of Superposition Theorem with DC.
5. Verification of principle of Thevenin's theorem with DC.
6. Verification of principle of Norton's theorem with DC.
7. Verification of principle of Maximum Power Transfer with DC.
8. Determine the frequency response of current in RL & RC circuit.
9. Determine the frequency response of current in RLC circuit.
10. Study of VI characteristics of PN junction diode.
11. Study ofVI characteristics of Zener diode.
12. Study ofVI characteristics of LED, LDR and Photodiode.
13. Study of VI characteristics of BJT in CE configuration.

ENGG 101L Engineering Drawing and Graphics Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**6**	**3**

Learning Outcomes

The Students will be able to:

- Apply the concepts of engineering drawing in their respective field of interest.
- Implement various BIS and ISO concepts of drawing.
- Draw the sectional views of various engineering objects.
- Use engineering curves in tracing the paths of simple machine components.
- Draw various views related to real objects.
- Draw and read plan of industrial standards.
- Visualize the design ideas using software.

Indian Standard –Drawing Instruments, Lines & Lines symbols; Sheet Layout of rules of printing; Line sections & Conventions, Lettering, Scales, Curved used in Engineering Practice, Projection of Points, Projection of Lines, Projection of Planes, Projection of Solids, Orthographic Projections, Sectional Views, Rivets & Riveting Joints, Threads, Foundation Bolts & Nuts.

Computer Aided Drawing using Auto CAD /MICRO STATION.

Text Books:

1. Gill,P. S. (2010).*Engineering Drawing*. Kataria Publication,.
2. Bhatt,N. D. & Panchal, V.M. (2011). *Geometrical and Machine Drawing* (19th ed.). Charotar Publication.

e-Resources:-

1. https://nptel.ac.in/courses/112103019/
2. http://www.me.umn.edu/courses/me2011/handouts/drawing/blanco-tutorial.html
3. https://ocw.mit.edu/courses/mechanical-engineering/2-007-design-and-manufacturing-i-spring-2009/related-resources/drawing_and_sketching/

4. https://nptel.ac.in/courses/112104172/

LIST OF EXPERIMENTS

1. Drawing sheet related to lettering.
2. Drawing sheet related to scale.
3. Drawing sheets related to conic sections.
4. Drawing sheets related to Engineering Curves.
5. Drawing sheet related to Projection of points.
6. Drawing sheet related to Projection of lines.
7. Drawing sheet related to orthographic projection by 1st angle.
8. Drawing sheet related to orthographic projection by 3rd angle.

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ENGG 103L Measurement Techniques Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**6**	**3**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Perform adulteration test and qualitative analysis of biomolecules.
- Familiarize with the working principle of microscope.
- Understand the fundamental concepts of plant identification and vegetational analysis.
- Gain hand on training to check purity of biomolecules.

Biology

1. To test for adulteration in turmeric, wheat flour, ghee and milk.
2. Qualitative analysis of nitrate, carbonate and replaceable base deficiency in soil samples.
3. Determination of soil pH.
4. Biochemical test for sugar, albumin and ketone bodies in urine samples.
5. Biochemical tests for lipids and cholesterol.
6. Detection of Vitamin A in the given sample.

7. Study of typical prokaryotic and eukaryotic cells with the help of a microscope.
8. Gram staining to identify gram positive and gram negative bacteria
9. Description of plant identification (Neem, Babool, Peeli Kaner, Tulsi & Chandani, Aak/ Madar).
10. Vegetational analysis by Quadrat method.
11. Determination of concentration and purity of DNA.
12. Determination of concentration and purity of RNA.
13. Preparation of stained temporary mount of onion peel.

Suggested Books:

- Biradar, V.K., & Samshe, A. (2016). *Practical Biochemistry*. New Delhi: APH Publishing Corporation.
- Sharma, S., & Sharma, R. (2016). *Practical Manual of Biochemistry* (2nd ed.). New Delhi: Medtech.
- Vats, S. (2015). *A laboratory Text book of Biochemistry, Molecular Biology and Microbiology*. Germany: GRIN Verlag.
- Yadav, V.K., & Yadav, N. (2018). *Biochemistry & Biotechnology: A Laboratory Manual*. Jaipur: Pointer Publisher.

MATH 209 Complex Variables

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

On completion of the course, students will be able to:

- Demonstrate an understanding of the basic concepts of underlying complex analysis.
- Explain the essential concepts of complex functions and their role in applied contexts.
- Investigate limit, continuity and differentiability of complex functions.
- Demonstrate capacity for mathematical reasoning through analyzing analytic functions.

- Use complex analysis techniques to solve problems in diverse situation in physics, engineering and other mathematical contexts.
- Demonstrate an understanding to determine the singularity of the complex functions
- Demonstrate an understanding of Fourier series, Fourier integrals and Fourier transforms.

Section A

Complex functions; Exponential function, Trigomometric and hyperbolic function, Polar form, branch cuts.Continuity, Differentiability, Analytic function, Cauchy-Riemann equations, Harmonic functions.

Section B

Conformal map, Bilinear Transformation, Line integral in complex plane, Cauchy's Integral theorem, Cauchy's integral formula, Derivative of analytic functions, Power series, Taylor's series, Laurent series,

Section C

Singularities, Residue, Residue theorem and Evaluation of real integrals.

Fourier series, half-range expansions, Fourier integrals, Fourier transforms: Fourier sine and cosine transform, Inverse Fourier transforms.

Suggested Books:

1. Kasana, H. S. (2005).*Complex Variables: Theory and Applications* (2nd ed.). India, Delhi:PHI Learning Pvt. Ltd.
2. Ramana, B.V. (2015), *Higher Engineering Mathematics* (25th ed.).India, Delhi: Tata McGraw Hill Co. Ltd.
3. Kreyszig, E. (2011). *Advanced Engineering Mathematics* (9^{th}ed.). Hoboken, NJ : John Wiley & Sons, Inc.

Suggested E-Learning Material:

1. Complex Analysis
   https://nptel.ac.in/courses/111103070/

MATH 210 Differential Equations

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

On completion of the course, students will be able to:

- Solve nth order homogeneous differential equations with constant coefficient and Euler Cauchy differential equations.
- Understand some methods such as Variation of parameters, Methods of undetermined coefficient and Frobenius method for solving a differential equation.
- Solve Laplace transformation, Inverse Laplace transformation.
- Solve Ordinary differential equation by using Laplace transformation.
- Solve homogeneous and non-homogeneous linear Partial differential equations with constant coefficients.
- Understand the use of Partial differential equations in solving Heat, Wave and Laplace equations.

Section A

Ordinary differential equation of the 1st order and 1st degree; Ordinary linear differential equation of nth order- homogeneous and non-homogeneous with constant coefficient; Euler Cauchy differential equations, Variation of parameters, Methods of undetermined coefficients, System of linear differential equations.

Section B

Power series solutions of ordinary differential equations,Frobenius Method, Legendre equation and Legendre polynomials, Bessel equations and Bessel functions of first and second kind.

Laplace transform and its properties; Convolutions, Inverse Laplace transform, application of Laplace transform for solving ordinary differential equations.

Section C

Partial differential equations of first order, homogeneous and non-homogeneous linear partial differential equations with constant coefficients, Classification of second order Partial differential equations; Solution of one dimensional wave and heat equation, solution of Laplace equation

Suggested Books:

1. Ramana, B.V. (2017). *Higher engineering mathematics*. Mc Graw Hill.
2. Kreyszig, E. (2005). *Advance engineering mathematics.* Wiley Eastern.
3. Zill, D.G. (2013). A first course in differential equation with modeling application. Cengage Learning.

Suggested E-Learning Material:

1. Differential Equations for Engineers
   https://nptel.ac.in/courses/111106100/
2. Differential Equations
   https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/
3. Differential Equations
   https://freevideolectures.com/course/3302/differential-equations-i
4. Differential Equations
   https://www.khanacademy.org/math/differential-equations

ENGG 201 Structure and Properties of Materials

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

The students will be able to:

- Relate fundamentals of material properties with its utilization
- Design and develop better products and equipment
- Identify needs and applications of materials economically.

Section A

Atomic bonding in solids: Bonding forces and energies; primary and secondary bonding; Metallic structures: unit cells, crystal systems, crystallographic directions and Miller-Bravais indices, linear and planar densities, close-packed crystal structures; Polymer structure: molecular weight, molecular configurations of polymer; Defects and dislocations: vacancies and interstitials dislocations, grain boundaries; Mechanical test behaviour of metals: elastic and plastic deformation.

Section B

Deformation mechanisms: slip system, plastic deformation, strengthening mechanisms; Diffusion; Phase diagram: phases, micro structure, phase equilibrium, Iron-carbon system: Fe-Fe3C phase diagram, development of microstructure in Fe-C alloys, mechanical behaviour of Fe-C alloy, Tempered Martensite; Kinetics of phase transformations: Avrami rate equation, correlation of properties to microstructure, isothermal transformation diagram, continuous cooling transformation.

Section C

Magnetic materials: dia, para, ferroand ferrimagnetism; soft and hard magnetic materials and their applications; Conductive materials: electrical properties of conductive and resistive materials, important characteristics and electronic applications of specific conductive & resistive materials; Semiconductor materials: crystal growth, zone refining, degenerated and non-degenerated semiconductors, direct and indirect band-gap semiconductors.

Recommended Books:

1. Callister, W. D., & Rethwisch, D. G. (2018). Materials science and engineering: An introduction.
2. Shackelford, J. F. (2014). Introduction to materials science for engineers. Pearson.
3. Viswanathan B. (2006). Structure and properties of solid state materials. Alpha Science Intl. Ltd .
4. Budinski, K. G., & Budinski, M. K. (2016). Engineering materials: Properties and selection. New Delhi: Pearson India Education.

E-resource(s): https://nptel.ac.in

ENGG 202 Basic Electronics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Understand the fundamental of semiconductors and design semiconductor circuits.
- Understand the different type of diode/ transistors with their responses.
- Analyze various types of oscillators available with their utilization.

Section A

Electronics component- Active & Passive components, Types of resistors, inductors & capacitors, Recapitulation of semiconductor, Intrinsic and Extrinsic Semiconductor, Charge density of semiconductors generation and recombination of charges, diffusion, the continuity equation, Injected minority carrier charges, potential variation with in a graded semiconductor, Potential variation in step graded junction, PN Junction diode, current components, volt Ampere characteristic-temperature dependency, space charge & diffusion capacitance, switching time

Section B

Breakdown diode, Tunnel diode, LED, Photo diode, load line, clipping, clamping. The junction Transistor, current, components, configuration - CB, CE, CC, Typical junction values, Ebers-Moll model, photo transistor, analysis of transistor amplifier using h parameter Transistor Hybrid Model, , Emitter follower, Darlington pair, Miller theorem & its Dual, cascading amplifier

Section C

Biasing and stabilization - Static & Dynamic, Bias stability, load line, Need of stabilization, self-bias, fixed bias, emitter bias, feedback bias, Transistor as an Inverter, brief introduction of different coupling techniques

FET- Pinch off, V-I characteristics, MOSFET- Depletion & Enhancement type, Oscillators- Barkhausen criterion, phase shift oscillator, General form of oscillator circuit - Colpitts, Hartley, Wein bridge, crystal oscillator

Recommended Books:

1. Millman. J, Halkias. C, Parikh. C. (2017). *Integrated Electronics. (2/e).* New Delhi: TMH Publications.
2. Boylestad.R. (2012). *Electronic Devices& Circuits Theory.(6/e).* New Delhi: Pearson Publications.
3. Somanathan B. Nair. (2006). *Electronics Devices and Applications.* New Delhi: Prentice Hall India Learning Private Limited
4. Smith. S.(2008). *Microelectronics Circuits. (5/e).* New Delhi: Oxford press, India.
5. Streetman Ben. G. (2006). *Solid State Electronic Devices (6/e)*. New Delhi: PHI Publications.

Suggested E-resources:

1. **Basic Electronics** by Prof. Pramod Agarwal, Department of Electrical Engineering, Indian Institute of Technology, Roorkee. https://nptel.ac.in/courses/117107095/4
2. **Circuits and Electronics** by Anant Agarwal, Massachusetts Institute of Technology: MIT OpenCourseWare. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/video-lectures/6002_l16.pdf

ENGG 202L Basic Electronics Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes:

After completion of this laboratory, the students will be able -

- To understand the various type of diodes and their VI characteristics.
- To understand the different diode circuits and their output behaviour.
- To understand the concept of cascading amplifier and its frequency response.
- To understand the various oscillators.

1. To study VI Characteristics of p-n junction diode.
2. To study VI Characteristics of Zener diode.

3. To study VI Characteristics of LED.
4. To study VI Characteristics of Photo diode.
5. To study VI Characteristics of LDR.
6. To study VI Characteristics of Photo transistor.
7. To study of various types of Clippers circuits.
8. To study of various types of Clampers circuits.
9. To study VI Characteristics BJT CB mode.
10. To study VI Characteristics BJT CE mode.
11. To study VI Characteristics of FET.
12. To study frequency response of single stage amplifier.
13. To study frequency response of double stage amplifier.
14. To study Colpitts & Hartley oscillator.
15. To study Wein bridge & crystal oscillator.

CS 209 Data Structures

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students will be able to:

- Develop knowledge of basic data structures for storage and retrieval of ordered or unordered data. Data structures include: arrays, linked lists, stacks, queues, binary trees, heaps.
- Develop knowledge of applications of data structures including the ability to implement algorithms for the creation, insertion, deletion, searching, and sorting of each data structure.
- Analyze and compare algorithms for efficiency using Big-O notation.
- Describe the concept of dynamic memory management, data types, algorithms, Big O notation.
- Apply Algorithm for solving problems like sorting, searching, insertion and deletion of data.

Section A

Concept of data types, Abstract data type, Data structures, running time of a program, asymptotic notations: Big-Oh, Theta, Little-oh, Omega. Linear

data structures: Static implementation of stack, queue, and their applications Searching and Sorting: Linear search and Binary Search, Bubble sort, Selection sort, Insertion sort, Quick sort, Radix sort.

Section B

Linked List: Linear, doubly or two way, circular, header and various operations; Representation of polynomial using linked list, addition and subtraction of polynomials. Dynamic implementation of stacks and queues. Dynamic memory management: fixed and variable block storage, storage techniques: first-fit, best-fit, worst-fit, next-fit; data compaction, and garbage collection.

Section C

Non linear data structures: Tree concepts, General Tree, binary tree and types, binary search tree, implementation of various operations on Binary Search Tree (tree traversal, searching, insertion and deletion, counting leaf and non-leaf nodes, height), Heap and heap sort, Balanced tree: concepts, rotations, insertion and deletion.

Suggested Books:

1. Langsam, Y., Augenstein, M., & Tenenbaum, A. M. (1996). *Data Structures using C and C++*. New Jersey: Prentice Hall.
2. Tremblay, J. P., & Sorenson, P. G. (1976). *An introduction to data structures with applications.* New York: McGraw-Hill.
3. Horowitz, E., Sahni, S., & Anderson-Freed, S. (2008). *Fundamentals of data structures in C.*Universities Press: Computer Science.
4. Aho, A. V., Hopcroft, J. E., & Ullman, J. D. (1983). *Data Structures and algorithms.* Addison Wesley Publishing Company.

Suggested E-Learning Material:

1. Programming and Data Structures
   https://swayam.gov.in/course/1407-programming-and-data-structures
2. Data Structures and Program Methodology
   https://nptel.ac.in/courses/106103069/

CS 209L Data Structures Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course students will be able to :

- Implement problems based on basic data structures like stack and queues.
- Implement problems on linked lists.
- Implement problems for performing different operations like insertion, deletion and searching on binary tree and binary search tree.

Lab Number	**Problems**
L1-L4	Implementation of stack, Applications of stacks (parenthesis checker, postfix evaluation, infix to postfix), recursion
L5-L7	Implementation of linear, circular, circular queue, priority queue
L8-L12	Implementation of linear link list (creation, traversal, insertion, deletion, searching, sorting, merging, reverse)
L13-L14	Implementation of circular link list (creation, traversal, insertion, deletion, searching, sorting)
L15-L16	Implementation of doubly link list (creation, traversal, insertion, deletion, searching, sorting)
L17	Linked representation of stack and queue
L18	Polynomial arithmetic (Addition, Subtraction)
L19-L28	Implementation of binary search tree (creation, traversal, insertion, deletion, searching), Non recursive traversal (inorder, preorder, postorder)
L29-30	Heap creation, insertion, deletion, heap sort

CS 214 Object Oriented Programming

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes:

After successful completion of the course students will be able to :

- Describe the features of C++ supporting object oriented programming.
- Explain the relative merits of C++ as an object oriented Programming language.
- Describe how to apply the major object-oriented concepts to implement object oriented programs in C++, encapsulation, inheritance and polymorphism.
- Apply advanced features of C++ specifically stream I/O, templates and operator overloading
- Apply other features of the C++ language including templates, forms of casting, conversions, and file handling.

Section A

Basic Concept of Object Oriented Programming: Need of OOP, advantage over other programming paradigms, Tokens, Keywords, Identifiers and Constants, Basic Data Types, Control Structures.

Functions: Call by Value, Call by Reference, Function Overloading.

Class & Objects: Concepts of Objects & Classes, declaring multiple objects, array of objects, Friend Functions.

Section B

Constructors and Destructors: Introduction, Default, Parameterized and Copy Constructor, Concept and use of destructors.

Operator Overloading: Overloading Unary Operators, Overloading Binary Operators.

Inheritance: Derived and Base Class, Public, Private, Protected, Multiple and Multilevel Inheritance, Function Overriding.

Pointers: Pointers to Objects, this Pointer, Virtual Functions, Polymorphism.

Section C

Console I/O: Concept of Streams, Hierarchy of Console stream Classes, Unformatted and formatted I/O Operations, Managing Output with Manipulators

Templates: Class and function templates, overloading of function templates

File Handling: Classes for file stream operations, open and close a file, EOF, file modes, file pointers and their manipulators, sequential I/O operations, updating a file-Random access, Error Handling During File Operation.

Suggested Books:

1. Balagurusamy, E. (2001). *Object Oriented Programming with C++, 6e*. Tata McGraw-Hill Education.
2. Schildt, H. (2003). *C++: The complete reference*. McGraw-Hill.
3. Lafore, R. (1997). *Object-oriented programming in C++*. Pearson Education.
4. Stroustrup, B. (2000). *The C++ programming language*. Pearson Education India.
5. Venugopal, K. R. (2013). *Mastering C++*. Tata McGraw-Hill Education.

Suggested E-Learning Material:

1. Stroustrup, B. (2000). *The C++ programming language*. Pearson Education India.

   http://www.stroustrup.com/C++.html
2. Programming in C++

   https://nptel.ac.in/courses/106105151/

CS 214L Object Oriented Programming Lab

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	4	2

Learning Outcomes:

After successful completion of the course students will be able to

- Implement problems based on expressions, arrays and strings.
- Carry out problems using functions, class, constructor and destructor.
- Implement problems using pointers, operator overloading, inheritance, file handling and exception handling.

Lab Number	Problems
1-8	Implementation of simple problems with the Objects and class. Understanding of private, public and protected access using problem, Implementation of static variable & static member function.Constructors & destructors. Problems using friend function.
9	Implementation of polymorphism.
10	Implementation of inheritance
11-16	Implementation of operator overloading to overload various operators: unary operators (+, -, *, % etc) and binary operators: +, *, [ ], >> and << operators on vectors
17-18	Problem related with dynamic binding. Problems using this pointer
19-20	Problems related with the templates function and template classes.

EEE 203 Network Analysis & Synthesis

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	3	1	0	4

Learning Outcomes

The Students will be able to:

- Analyze circuits using circuit laws.
- Develop the understanding of the circuit theorems in network reduction.
- Understand the behavior of various circuit elements in transient conditions and evaluate the responses
- Analyze the different types of network functions by identifying poles and zeros
- Characterization of a two port network

Section A

Circuit fundamentals and analyzing tools: Review of basics of DC network, Graph theory, tree, Loop and Nodal Analysis, tie set matrix, incidence matrix.

AC Network Theorems: Thevenin's, Norton's, Superposition, Reciprocity, Tellegen's, Millman's and Maximum power transfer theorem, Duality, method of obtaining dual network.

Section B

Transient behavior and initial condition: LTI System, complex frequency, behavior of circuit elements under switching condition and their representation, evaluation of initial and final conditions in RL, RC and RLC circuit for AC and DC excitation.

Applications of Laplace Transform for electrical circuit: Review of Laplace transforms, solution of circuits, response of networks to step, ramp, impulse, exponential and sinusoidal inputs. Waveform Synthesis.

Section C

Two Port Networks: Network parameters-Z, Y, ABCD and h-parameter, properties of driving point transfer functions, interconnection and cascading of two port networks, ladder and lattice networks, T and π representation.

Network Synthesis: Realization of RL, RC and RLC, significance of poles and zeros, physical realization, Hurwitz criterion, Foster and Cauer realization, ladder development.

Text Books

1. Valkenburg,M.E.V.(2006). *Network Analysis*. Prentice Hall.

2. Malley, J.O. (2011). *Schaum's outline of Basic Circuit Analysis*. Mcgraw Hill.

Reference Books

1. Chakrabarti,A.K. (2018). *Circuit Theory* (7th ed.). Dhanpat Rai and Co.
2. Alaxender, C.&Sadiku, M. N. O. (2003). *Fundamentals of Electrical circuits.* Oxford University Press.
3. Choudhary, D. R.(2013). *Networks and Systems.* Wiley Eastern Ltd.
4. Wadhwa,C.L.(2007).*Network Analysis and Synthesis*, New Age international Publishers.
5. Scott,D. E. (1987). *An Introduction to Circuit Analysis: a system approach*. Mcgraw hill.

E-Resources:-

1. https://nptel.ac.in/courses/108102042/
2. https://www.edx.org/course/circuits-electronics-1-basic-circuit-mitx-6-002-1x-0
3. https://www.coursera.org/learn/linear-circuits-ac-analysis
4. https://swayam.gov.in/course/3868-networks-and-systems
5. https://www.researchgate.net/publication/307984500_Circuits_and_Networks_Analysis_Design_and_Synthesis_2e
6. http://www.covasa.cl/network-analysis-and-synthesis-by-franklin-f-kuo-solutions-free.pdf
7. http://www.nptelvideos.in/2012/11/circuit-theory.html

EEE 203L Network Analysis and Synthesis Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Identify, formulate and solve electrical network
- Analyse behavior of circuit elements

- Calculation of impedance and admittance parameters of a given network

LIST OF EXPERIMENTS

1. To verify the Kirchhoff's Current law.
2. To verify the Kirchhoff's Voltage law.
3. To verify the Superposition theorem.
4. To verify the Thevenin's theorem.
5. To verify the Norton's theorem
6. To verify the Reciprocity theorem.
7. To verify the maximum power transfer theorem.
8. To verify the Millman'stheorem.
9. To verify the Tellegen's theorem
10. To determine two port network parameters using π network.
11. To determine two port network parameters using T network.

ELE 206 Digital Electronics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
- To understand, analyze and design various combinational and sequential circuits, Counters and registers.
- To design state machine diagrams and applications of Logic families
- Utilize the knowledge of memory devices and ADC/DAC in digital design applications.

Section -A

Review of Number Systems, Binary arithmetic & codes. Logic Gates: Logic Gates and Boolean Algebra Representation and Simplification of

functions by Map methods, minimal function and their properties, tabulation procedure for determination of prime implicates, the prime implicant chart. Combinational Circuits design. Adder, Subtractor, Decoder, Demultiplexer, Encoder, Multiplexer, Comparator, three state devices, Exclusive-OR gates and parity circuits.

Section- B

Sequential Logic Circuit & Design – latches and flip flop, synchronous sequential circuits – finite state model, memory elements and their Excitation function, clocked synchronous state machine analysis and design, asynchronous and synchronous counters, state reduction and assignment, design procedure and design of counter, shift register.

Section- C

Digital Logic Families and Their Characteristics: RTL, DTL, TTL, Schotlky TTL, ECL, MOS and CMOS, Fan in, Fan out.

Semiconductor Memories**:** RAM, ROM, PROM, EPROM, BJTRAM Cell, MOS RAM Cell, and Organization of RAM.

D/A Converter: Weighted resistance D/A, R-2R Ladder Converter. DAC 0800 D/A Chip, D/A Converter specification. **A/D Converter:** Analog to Digital Converter, Parallel Comparator Converter, Counting Converter, Successive Approximation Converter, Dual Slop converter, A/D converter specification, sampling and hold circuit.

Text Books:

1. Kumar, A.A. (2016). *Fundamental of Digital Circuits*(4th ed.).New Delhi: PHI.
2. Floyd, T.L.(2011).*Digital Fundamentals* (8thed.).Pearson Education.
3. Kharate, G.K. (2010). *Digital Electronics* (5th ed.).Oxford University Press.
4. Bignell, J. & Donovan, R. (1999) *Digital Electronics Logic and Systems.*Cengage Learning.
5. Malvino, A.P. & Leach, D.P. (2011).Digital Principles and Applications (8thed.). McGraw Hill.

Reference Books:

1. Mano, M. Morris.(2007). *Digital Logic and Computer Design.* Pearson Education.

2. Malvino, A. P. &Brown,J. (2017). *DigitalComputer Electronics* (3rd ed.). Tata McGraw Hill.

e-Resources:-

1. https://www.educba.com/course/online-digital-electronics-courses/
2. https://www.coursera.org/learn/digital-systems
3. https://www.udemy.com/topic/digital-electronic/
4. https://onlinecourses.nptel.ac.in/noc19_ee09/preview
5. https://swayam.gov.in/course/1392-digital-circuits-and-systems
6. https://nptel.ac.in/courses/106108099/Digital%20Systems.pdf
7. https://nptel.ac.in/courses/117106114/Week%202%20Slides/2.1Universality.pdf
8. https://nptel.ac.in/courses/108101091/Week%2010%20Slides.pdf
9. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/
10. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/video-lectures/

ELE 201L Digital Electronics Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- The students will become competent enough to identify different digital integrated circuits utilized in complex electronic circuits.
- Students will have the ability to put together the knowledge of combinational logic circuits in designing of real time applications.
- The students will become proficient in designing of basic memory elements and their applications.
- Students will have the ability to implement various real life applications using asynchronous sequential logic circuits.

LIST OF EXPERIMENTS

1. To verify the truth table of various Logic gates.
2. To implement the X-OR gate with the help of Universal Gate -NAND.
3. To implement the X-NOR gate with the help of Universal Gates - NOR.
4. Verification of theorems of Boolean algebra.
5. Study of Binary Adder &Subtractor (Half).
6. Study of Binary Full Subtractor.
7. Study of Binary Full Adder.
8. Study of Multiplexer (2*1) and Demultiplexer (1*2) circuits.
9. Study of Decimal to Binary Decoder (2*4) and Encoder (4*2).
10. Study and designing with the help of gates of flip-flops (SR, D).
11. Study and designing with the help of gates of flip-flops (JK, T).
12. Study and designing with the help of gates of circuit of given Binary Up asynchronous counter.
13. Study and designing with the help of gates of circuit of given Binary Down asynchronous counter.

EIE 204 Electrical and Electronics Measurements

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Student will analyze the performance of industrial measurement systems.
- Student will identify different type of transducers used in various real-time processes.
- Measurement of various electrical quantities can be carried out by students.
- Student will be able to design the bridge circuits used in measurement task.

- Systems will have ability to operate different waveform analyzers and Cathode ray oscilloscope employed for measurement of electrical qualities.

Section A

Measurements: Elements of Measurements, Performance characteristics, Error in measurements, True value, Static error, Static correction, Scale range, Scale span, Reproducibility, Drift, Repeatability, Accuracy and Precision, Indication of Precision, Significant figures, Range of doubt, Static sensitivity, Linearity, Hysteresis, Threshold, Dead Time, Dead zone, Resolution and Discrimination.

Measurement error: Types and analysis, Loading error due to series and shunt connected instruments, Standards and Calibration, Curve fitting, Dynamic characteristics of measurement systems, Mathematical models of measurement system (Mechanical and Electrical System).

Transducers: Classification and characteristics, Resistive, Capacitive, Inductive, Hall Effect. **Measurement of Displacement:** LVDT and RVDT, Strain Gauges and its types.

Measurement of Temperature: RTD, Thermistor and Thermocouples.

Section B

D'Arsonval Galvanometer- Construction, Torque Equation and Dynamic behavior of galvanometers, PMMC Instrument- Construction, Torque equation, Ammeter shunts, Voltmeter multipliers, Ohmmeter- Series and Shunt type, Moving Iron Instruments, Electrodynamometer Instrument. AC Bridges- Measurement of self-inductance (Maxwell's Bridge, Hay's Bridge, Owen's Bridge, Anderson's Bridge), capacitance (De Sauty's and Schering Bridge) and frequency (Wien's Bridge).

Section C

Measurement of low, medium and high resistance. Multimeter- Analog and Digital, Function generator, Wave Analyzer, Spectrum Analyzer, Q-meter and its applications, CRO- CRT, Time base generator, Measurement of Phase and Frequency (Lissajous Patterns), types of CRO (Dual Trace, Dual Beam, Sampling type and Storage CRO).

Text Books:

1. Sawhney, A. K. (2015). *A Course in Electrical and Electronic Measurements and Instrumentation*. Dhanpat Rai Publication.

2. Jain, R.K. (2015). *Mechanical and Industrial Measurements*. Khanna Publishers.
3. Nakra, B.C. &Choudhary, K.K. (2016). *Instrumentation, Measurement and Analysis* (4th ed.). Tata McGraw Hill.

Reference Books:

1. Doebelin, E. O. (1990). *Measurement Systems:Application and Design* (4th ed.). Mcgraw Hill International.
2. Eckmann, D. P.(2006). *Industrial Instrumentation*. CBS Publishers and Distributors.
3. Kalsi, H.S. (2017).*Electronic Instrumentation*(3rd ed.). Mcgraw Hill Education.
4. Singh,S.K. (2017). *Industrial Instrumentation and Control*(3rd ed.).Mcgraw Hill Education.
5. Rangan, C., Sharma, G. & Mani, V.S.V. (2017*). Instrumentation: Devices and systems*(3rd ed.).Mcgraw Hill Education.

e-Resources:-

1. https://nptel.ac.in/courses/108106070/
2. https://swayam.gov.in/course/3764-industrial-instrumentation
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-071j-introduction-to-electronics-signals-and-measurement-spring-2006/download-course-materials/
4. http://www.bput.ac.in/lecture-notes download.php?file=lecture_note_212311150212320.pdf

EIE 202L Electrical and Electronics Measurements Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Recognize various materials by employ different sensors.
- Understand the working of different types of sensors and its applications.

- Student will be able to control and monitor industrial processes.
- Analyze various response of the system with the help of Digital Storage Oscilloscope.

LIST OF EXPERIMENTS

1. Material detection using Inductive sensor and to calculate its switching hysteresis.
2. Material identification using Capacitive sensor and calculate its Reduction factor.
3. Material recognition using Magnetic sensor and plot its switching characteristics.
4. Material identification using Ultrasonic sensor and calculate its switching hysteresis.
5. Object detection using Photo electric sensors and calculation of their switching frequency.
6. Level detection with the help of Ultrasonic, Photo electric and capacitive sensors.
7. Design of logical operations (AND & OR) using different type of sensors.
8. Design of Wheatstone bridge and compute its unknown resistance.
9. To calculate the frequency and phase with Lissajous pattern using DSO.

EIE 204L Electrical and Electronics Measurements Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Develop an understanding of construction and working of different measuring instruments.
- Develop an ability to use measuring instruments and AC and DC bridges for relevant measurement.

- Select appropriate passive or active transducers for measurement of physical phenomenon.

List of experiments:

1. To study Hall Effect.
2. To study principle of Thermocouple.
3. To study principle of Load cell.
4. To study principle of Thermistor.
5. To study principle of strain guage.
6. To study Principle of LVDT
7. To study De Sauty bridge.
8. To study Wein AC bridge.
9. To study CRO circuitry in detail.

MCTR 201 Pneumatic Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- The students will be able to explain the detailed functioning of Pneumatics Engineering.
- Students will be able to explain the properties of control elements based upon physical principles, and the roles they play within the system.
- By understanding and performing measurements on the pneumatic and control circuits, students will learn and apply troubleshooting strategies.
- To impart the knowledge of electro-pneumatics-systems.
- To impart the knowledge of Concepts, Design and Applications of Pneumatics Engineering.

Section-A

Introduction to Pneumatic energy, Gas laws (Boyle's law, Charles' law, Gay-Lussac's law), Generalized gas equation,Preparation of compressed air, Compressor and its type (Piston, Screw, Reciprocating, Rotary and Axial), Air Storage System, Dryers, Maintenance and troubleshooting of Pneumatic system.

Section-B

Elements of pneumatic system: Filter, Regulator and Lubricator (FRL) unit, Direction Control Valves (DCV), Flow Control Valves (FCV), Pressure Control Valves (PCV), Time delay, Quick Exhaust, Twin pressure and Shuttle valves, Non-Return Valves (NRV), Pilot-operated check valves

Pneumatic Actuator: Linear, Rotary and Limited angle actuators

Classification and types of Cylinders, Cushioning, Seals, ISO symbols

Section-C

Electro-pneumatic circuits: solenoid valves, switches (push button, detent and limit), relays, reed& proximity switches, Switch Mode Power Supply (SMPS).

Direct and Indirect actuation, Development of single and multi actuator circuits, speed control of cylinders, supply air throttling and Exhaust air throttling.

Signal Processing Elements: Use of logic gates(OR and AND) in pneumatic applications. Introduction to Vacuum Technology& its application.

Text Books:

1. Jagadeesha, T. (2015). *Pneumatics: Concepts, Design and Applications*. Universities Press (India) Private Limited,

2. Sundaram, K.S.(2006). *Hydraulic and Pneumatic Controls: Understanding made Easy*. S. Chand Limited.

3. Majumdar,S.R. (1996). *Pneumatic Systems: Principle and Maintenance*. Tata McGraw-Hill Education.

e-Resources:-

1. https://nptel.ac.in/courses/112105046/
2. https://www.hydraulicspneumatics.com/

3. https://www.coursera.org/lecture/fluid-power/hydraulics-and-pneumatics-SD8dv
4. http://www.180skills.com/manufacturing-skills-courses/pneumatics-skills-courses/

MCTR 201L Pneumatic Engineering Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Explore fundamentals of pneumatics and identify the different types of pneumatic system and circuit.
- Student will be able to assemble pumps and motors to rectify problems.
- Introduce efficient deign of pneumatic system.
- se software to simulate the pneumatic circuits.
- Build, Test and Troubleshoot pneumatic system.

LIST OF EXPERIMENTS

1) Direct control of single and double acting cylinders.
2) Controlling double acting cylinder with impulse valve.
3) Logical (AND & OR) control with shuttle & twin pressure valve.
4) Operation of single and double acting cylinder using pilot operated directional control valve.
5) Operation of double acting cylinder using relay and solenoid valve.
6) Apply AND, OR logic using solenoid valve and two manual controls for forward stroke of a double acting cylinder.
7) Continuous operation of a double acting cylinder sing double solenoid valve.
8) Simulation for condition monitoring of double acting cylinder.
9) Simulation of PID Controller in Feed Forward mode.
10) Operation of Double Acting Cylinder using PLC.
11) Study of vacuum technology.

ELE 202 Electromagnetic Field Theory

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes:

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

- Apply vector calculus in static and varying electric-magnetic fields in different engineering situations.
- Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems.
- Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.

Section A

Elements of Vector calculus: Cartesian coordinate system, Circular-Cylindrical coordinate system, Spherical coordinate system (dot product, cross product, divergence & curl). Electrostatics: Electric Flux Density, Coulomb's law, Gauss's law and their applications, Energy in electrostatic fields, capacitance of parallel plate and coaxial cable, Fields in dielectrics, Boundary conditions, dipole, Laplace's and Poisson's equations and their applications.

Section B

Magnetostatics: Ampere's law, Biot-Savart's law and their applications, Stock's theorem, Energy in magnetic field, Boundary conditions. Maxwell's Equation: - Maxwell's equations in integral &differential form (Gauss's law in electric and magnetic field, Ampere's circuital law, Faraday's law), Maxwell's equations for time varying field.

Section C

Uniform Plane Waves: Wave equation and its solutions, Pointing vector, propagation through various media-free space, conductor & dielectric, Reflection and Refraction in conductors & Dielectrics with normal and oblique incidence, Phase & Group velocity, Skin depth. Transmission Lines: General equation, input impedance, characteristic impedance, Reflection and reflection coefficient, Standing wave ratio, resonant and anti-resonant lines, impedance matching, Smith chart and its applications, practical problems in transmission lines.

Text Books:

1. Sadiku,M. N. O., Kulkarni,S. V., (2009). *Principles of Electromagnetics*. Oxford University Press.
2. William H. Hayt,(2017). *Engineering Electromagnetics*. McGraw Hill.

Reference Books:

1. Jordan,E. C., Balmain,K. G. (1968). *Electromagnetic Waves and Radiating Systems*. Pearson.
2. Kraus,J. D., Fleisch,D. A., (2017). *Electromagnetics with Applications*. McGraw Hill.

e-Resources:

1. https://nptel.ac.in/downloads/115101005/
2. https://nptel.ac.in/downloads/108104087/
3. https://www.coursera.org/
4. https://swayam.gov.in/course/1361-introduction-to-electromagnetic-theory
5. https://swayam.gov.in/courses/4907-july-2018-introduction-to-electromagnetic-theory

   https://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring-2008/chapter-1/

EEE 306 Electrical Machines-I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Understand the principle of electro-mechanical energy conversion
- Analyse the construction, classification and circuit model of DC machines
- Analyse the characteristics of DC machines and obtain their performance parameters

- Conduct various tests on the single phase transformer
- Apply various connection of three phase transformers for multiple applications

Section-A

Principles of Electro-mechanical Energy Conversion: Introduction, flow of Energy in electromechanical devices, energy in magnetic systems (defining energy & Co-energy), **Singly Excited Systems:** Determination of mechanical force, mechanical energy, torque equation, **Doubly excited Systems:** Energy stored in magnetic field, electromagnetic torque, Generated EMF in machines, torque in machines with cylindrical air gap.

Section-B

D.C. Machines: Construction of DC Machines, armature winding, EMF and torque equation, armature reaction, commutation, interpoles and compensating windings, performance characteristics of D.C. generators, performance characteristics of D.C. motors, **Starting of D.C. motors:**3 point and 4 point starters, **Speed control of D.C. motors:** field control, armature control and voltage control (Ward Lenonard method), **Efficiency and Testing of D.C. machines:** Hopkinson's and Swinburn's Test.

Section-C

Single Phase Transformer: Phasor diagram, efficiency and voltage regulation, all day efficiency,**Testing of Transformers:** O.C. and S.C. tests, Sumpner's test, polarity test.

Auto Transformer: Single phase Auto-transformer, volt-amp relation, efficiency, Conversion of a two-winding Transformer to an Auto transformer, saving in conductor material, advantages, disadvantages and applications of autotransformers.

Three Phase Transformers: Construction, three-phase unit transformer and bank of three single phase transformers with their advantages, three-phase transformer groups (phasor groups) and their connections, Y-Δ connection, open delta connection, three-phase/two-phase Scott connection and it's application, Sumpner's test, all day efficiency, polarity test excitation phenomenon in Transformers, harmonics in Single phase and 3-phase transformers, parallel operation and load sharing of single phase and three phase transformers, three winding transformers, tertiary winding.

Text Books:

1. Nagrath, I. J. &Kothari, D. P. (2017), "*Electrical Machines*" (3rdEdn.), Tata McGraw Hill.
2. Ashfaq , H. (2016), "*Electrical Machines*" (5thEdn.), Dhanpat Rai & Sons.
3. Fitggerald, A. E., Kingsley Jr., C. and Umans (2009), "*Electric Machinery*" (6thEdn), McGraw Hill, International Student Edition.
4. Gupta, B. R. &Singhal, V. (2005) "*Fundamentals of Electrical Machines*" (3rdEdn.), New Age International.

Reference Books:

1. Kosow, I. L. (2009).*Electric Machine and Tranformers* (2ndEdn.). Prentice Hall of India.
2. Say, M. G. (2005). *The Performance and Design of AC machines* (4thEdn.), Pit man & Sons.
3. Guru, B. S. and Hizirogulu, H. R. (2001). *Electric Machinery and Transformers* (3rdEdn.). Oxford University Press.

E-Resources:

1. https://eleccompengineering.files.wordpress.com/2014/08/stephen_chapman_electric_machinery_fundamentalsbookfi-org-1.pdf
2. http://solidviews.com/OaOY
3. https://kahrbjy.files.wordpress.com/2012/08/principles-of-electric-machines-solution-manual.pdf

EEE 202L Electrical Machines-I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Formulate and analyse working of DC machine and transformer
- Troubleshoot the operation of an electrical machine

- Select suitable measuring instrument for measurement of electrical parameters
- Exposition of advanced methods of controlling electrical machines

LIST OF EXPERIMENTS

1. To demonstrate basic safety measures in electrical system.
2. To study the operation of wiring system for in house loads.
3. To determine Power factor of R, L, C and RLC Circuit.
4. To obtain equivalent circuit and performance parameter of a single phase transformer.
5. To demonstrate the parallel operation of single phase Transformer and to obtain theload sharing at a particular load.
6. To control speed of DC series motor.
7. To control speed of DC separately excited motor.
8. To obtain losses &efficiency of compound motor-generator set.

ECE 201 Signals, Systems and Networks

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Analyze linear time invariant system in time and frequency domain
- Apply network theorem to analyze the electrical circuit.
- Explain two port parameters.

Section-A

Introduction: Continuous and discrete time signals, Transformation of independent variables, Exponential and sinusoidal signals, Unit impulse and unit step functions, Continuous and discrete time systems, Basic system properties

Linear Time-Invariant System: Convolution for continuous and discrete time LTI system, Properties of LTI system, Causal LTI systems described by differential and difference equations, Singularity functions

Fourier Series: Fourier series representation of continuous time periodic signals, Convergence of Fourier series, Properties of continuous time Fourier series, Fourier series representation of discrete time periodic signals, Properties of discrete time Fourier series

Section-B

Continuous Time Fourier Transform: Representation of a periodic signals, Fourier transform for periodic signals, Properties of continuous time Fourier Transform, Systems characterized by constant coefficient differential equations

Laplace Transform: Laplace transform, Region of convergence for Laplace transform, Inverse Laplace transform, Geometrical evaluation of Fourier Transform from pole-zero plot, Properties of Laplace transform, Analysis and characterization of LTI systems using Laplace transform

Initial Conditions in Networks: First order differential equations- General and Particular solutions, Time constants, Initial conditions in elements, geometrical interpretation of derivatives, A procedure to evaluate initial conditions

Section- C

Differential equation in circuits: Second order equations-Internal excitations, Networks excited by external energy sources, Response as related to the s-plane location of roots, General solutions in Terms of S, Q, ω_n

Impedance Functions and Networks Theorems: The concept of complex frequency, Transform impedance and transform circuits, Series and parallel combinations of elements, Superposition and Reciprocity, Thevenin's Theorem and Norton's Theorem

Two port Parameters: Relationship of two port variables, Short circuit admittance parameters, Open circuit impedance parameters, Transmission parameters, Hybrid parameters, Relation between parameter sets, Parallel connection of two port networks

Recommended Books:

1. Oppenheim A. V., A. V. &Nawab S. H. (2015). *Signal and Systems (2/e)*, Boston: Pearson Publication
2. Valkenburg M.E. Van (2015). *Network Analysis (3/e)*. New Delhi: Pearson Publication

3. Proakis J. G. &Manolakis D. G. (2007). *Digital Signal Processing: Principles, Algorithms, and Applications (4/e)*. New Delhi: Pearson Publication
4. Kuo F. F. (2010). *Network Analysis and Synthesis (2/e)*. New Delhi: John Wiley & Sons Publication

Suggested E-resources:

1. **Circuit Theory** by Prof. S.C. Dutta Roy, Department of Electrical Engineering, Indian Institute of Technology, Delhi. https://nptel.ac.in/courses/108102042/
2. **Principles of Signals and Systems** by Prof. Aditya K. Jagannatham, Department of Electrical Engineering Indian Institute of Technology, Kanpur. https://nptel.ac.in/courses/108104100

ECE 201L Signals, Systems and Networks Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes: After completion of this laboratory, the students will be able to-

- To understand the various type of signals and their application in analysis of different systems.
- To understand the signal behaviour in time domain and frequency domain.
- To understand the various AC network theorems.

1. Write a program to generate the following functions: Unit Impulse, Unit Step, Unit Ramp, Sinusoidal, Exponential, Random signal.
2. Write a program to study the basic operations on the discrete time signals: Amplitude Scaling, Time Shifting, Time Scaling, Folding, addition and multiplication of two signals.
3. Write a program to check for linearity, causality and stability of discrete time system.
4. Write a program to perform Linear and Circular Convolution.
5. Write a program to perform the Discrete Fourier transform and Inverse Discrete Fourier transform for the given sequences.
6. To verify Kirchhoff's current law and Kirchhoff's voltage law for AC Circuits.

7. To verify Norton's Theorem for AC Circuits.
8. To verify Thevenin's Theorem for AC Circuits.
9. To verify Superposition Theorem for AC Circuits.
10. To verify maximum power transform's Theorem for AC Circuits.

ECE 202S Seminar

Max. Marks : 100	**L**	**T**	**P**	**C**
	0	**0**	**2**	**1**

Learning Outcomes: After successful completion of the course, student will be able to:

- To identify promising new directions of various cutting edge technologies.
- Undertake a critical review of the literature.
- Deliver well-organized technical presentations and prepare a technical report.

ELE 205 Semiconductor Devices and Circuits

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the energy bands, temperature effects, carrier transport of semiconductor devices
- Explain the switching times, capacitance of PN junction, bipolar and unipolar transistor behavior and their differences
- Analyze the various feedback circuits and design power amplifiers.

Section A

P-N junction: thermal equilibrium condition, under forward and reverse bias, space charge region, junction capacitance, p-n junction current, small signal model, diode current equation, junction breakdown, charge storage

and transient behavior, metal semiconductor junction: Schottky Barriers and Ohmic Contacts, heterojuntion: energy band diagrams

Section B

Bipolar Junction Transistor: the transistor action, minority carrier distribution, low frequency common-base current gain, MOSFET: The MOS diode, Energy band diagrams, MOSFET fundamentals, MOS Transistor current, Threshold Voltage. FET biasing: fixed-Bias configuration, self-Bias configuration, Voltage-divider Bias configuration, FET small signal model, common source and common drain amplifiers.

Section C

Feedback amplifier: classifications of amplifiers, general feedback structure, properties of negative feedback, feedback topologies, Transfer gain with feedback, General Characteristics of negative feedback amplifiers, Input resistance, output resistance, Voltage series and current series feedback, Current shunt and voltage shunt feedback, Power amplifiers: Classification, operation, Analysis and design of Class A, Class B, Class-AB, Class C, Power dissipation and efficiency calculations, amplifier distortion.

Recommended Books:

1. S. Simon. M.(2002), *Semiconductor Devices Physics and Technology (2/e)* , New Jersey, USA: JOHN WILEY & SONS Publication
2. Millman. J, Halkias. C, Parikh. C. (2017). *Integrated Electronics. (2nd ed).* New Delhi: TMH Publications.
3. Streetman Ben. G. (2006). *Solid State Electronic Devices (6th ed)* New Delhi: PHI Publications.
4. Smith. S.(2008). *Microelectronics Circuits. (5th ed).* New Delhi: Oxford press.

Suggested E-Resources:

1. **Semiconductor Devices and Circuits** by Prof. Sanjiv Sambandan, Department of Instrumentation and Applied Physics, Indian Institute of Science, Bangalore. https://nptel.ac.in/courses/108108112/
2. **Analog Electronic Circuits** by Prof. S. C. Dutta Roy, Department of Electrical Engineering Indian Institute of Technology Delhi. https://nptel.ac.in/courses/108102095/

ELE 205L Semiconductor Devices and Circuits Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Develop understanding of current voltage characteristics of various semiconductor devices.
- Design and analyze the various electronic circuits such as amplifiers and oscillators.
- Draw output waveforms of various clipper and clamper circuits.

List of Experiments:

1. To study the half wave and full wave rectifier circuit.
2. Measurement of bipolar junction transistor (BJT) characteristics.
3. Measurement of junction field effect transistors (JFET) characteristics.
4. To measure input and output characteristics and calculate gain of CE amplifier circuit.
5. To measure input and output characteristics and calculate gain of CB amplifier circuit.
6. To study the frequency response of RC coupled amplifier.
7. To study Wien-bridge oscillator circuit.
8. To study Hartley oscillator circuit.
9. To study the effects of negative feedback on the amplifier characteristics.
10. Study of class A push-pull amplifier.
11. Study of class B push-pull amplifier.
12. To study clipper and clamper circuits.

ECO 307 Fundamentals of Economics

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	3	0	0	3

Learning Outcome:

Upon Completion of the course student will be able to:

- Understand various aspects of economics that affects the day today functioning of business.
- Understand the concept of demand, supply and production and how the same is related to market.
- Understand the basic financial concepts that affects the functioning of the business.

Section A

What Economics is all about? Micro and Macro Economics.Origin and meaning of Engineering Economics, Role of Economics in Engineering, Scope of Engineering Economics.

Theory of Demand: Law of Demand, Demand Function and Determinants of Demand, Types of Demand.

Elasticity of Demand: Concept, Types and Measurement.

Section B

Production function and Laws of Production.Optimal Input combination. Cost concepts and cost output relationship.

Types of market structures; Determination of equilibrium price and output under perfect competition.

Section C

Timevalue of Money and Project Evaluation: Interest Formulas; Cash Flow Diagram; Principles of Economic Equivalance, Evaluation of Engineering Projects using methods of Present Value and Internal Rate of Return.

Capital Budgeting: Concept and significance of capital budgeting.

Depreciation Analysis: Meaning and causes of depreciation; methods of calculating depreciation – straightline and declining balance methods.

Books Recommended:

1. Thuesen. G.J., and Fabrycky, *N.Engineering Economy, (9 ed)* PHI Learining Private Limited, New Delhi.
2. S. ParkChan: *Contemporary Engineering Economics:* 3rd Edition, Prentice Hall.
3. M. Parkin: *Economics:* 5th Edition, Addison Wesley.
4. Mahendra P. Agasty: *Engineering Economics and Costing, Second Edition:* Scitech Publications (India) Pvt. Ltd.
5. R. Panneerselvam: *Engineering Economics, Tenth Printing:* PHI Learning Private Limited, New Delhi.

MGMT 310 Principles of Management

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning Outcome:

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

- Evaluate the global context for taking managerial actions.
- Understand conflict resolution, motivation and leadership.
- Understand application of theories and management principles.

Section-A

What is management? Scientific approach-Taylor's contribution, administrative approach-Henry Fayol's contribution, human relation approach-Elton Mayo's contribution, system approach.

Planning: Need and process, types of plans-goals, objectives, policies and strategies; decision making-situations and process.

Section-B

Organizing: Organization structure, departmentation, centralization v/s decentralization, span of management, delegation and power of authority. Motivation-importance, theories of motivation-Maslow, McClleland Herzberg, theories.

Section-C

Theories and styles of leadership-Trait, behavioral.

Communication: Process and principles, types of communication, barriers to communication.

Control: Process of evaluation & control, method of control.

Suggested Reading:

1. Tripathi, P. C., & Reddy, P. N. (2017) Principles of Business Management, (22ed.) Tata McGraw Hill, New Delhi
2. Robbins & D. Cenzo. *Fundamentals of Management (10ed)*, New Delhi, Pearson Education Asia
3. Prasad,L.M.*Principles and practice of Management (9ed)* .Sultan Chand & sons, New Delhi
4. Weihrich&Koonts. *Management-A Global Perspective (13ed)*, Tata McGraw Hill, New Delhi

Suggested E-Learning Material:

1. Prachi, J. (2016). *Planning Function of Management*. Retrieved from Management Study Guide:

   https://www.managementstudyguide.com/planning_function.htm
2. Amit,L. (2018, December). *Controlling: Features,process and types*. Retrieved from: https://www.youtube.com/watch?v=JRVXfaFrMEM
3. Brian, T. (2017, May 11). *Different Types of Leadership Styles*. Retrieved from: https://www.youtube.com/watch?v=vilZazhIjoc
4. Chandan,P (2017, September 26). *Organising:Meaning,Process and Types*. Retrieved from

   https://www.youtube.com/watch?v=XrmJG_8d9Cg

MATH 311 Numerical Methods

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	3	1	0	4

Learning Outcomes:

After successful completion of the course students will be able to

- Apply numerical methods to obtain approximate solutions to mathematical problems.
- Analyze and evaluate the accuracy of common numerical methods.
- Solve the nonlinear equations, system of linear equations and interpolation problems using numerical methods with error analysis.
- Examine the appropriate numerical differentiation and integration methods to solve engineering problems.
- Analyze the appropriate numerical method to find the eigen values and corresponding eigenvectors of a system.
- Apply the numerical methods to solve differential equations.

Section A

Errors analysis- Approximations and round off and truncation errors, Root finding for nonlinear equations (transcendental and algebraic equations); Iterative method, Bisection method, Regula-Falsi method, Newton Raphson's method, Order of convergence, Numerical methods for solving system of linear equation, Ill-conditioning.

Section B

Finite differences, Interpolation, Newton's formula for forward and backward interpolation, Newton's general interpolation formula, Lagrange's interpolation formula, Numerical differentiation.

Section C

Numerical integration; Newton's cotes quadrature formula, Trapezoidal, Simpson's rules. Numerical solution of first and second order differential equations, Euler's method, Picard's method, Runge-Kutta's method.

Suggested Books:

1. Rao, K. S. (2006). *Numerical Methods for Scientists and Engineers* (3rd ed.). PHI learning, India.

2. Ramana, B.V. (2015). *Higher Engineering Mathematics* (25th reprint). McGraw Hill.
3. Kreyszig, E. (2011). *Advanced Engineering Mathematics* (9thed.). Wiley Eastern.

Suggested E-Learning Material:

1. Introduction to Numerical Analysis for Engineering
   https://ocw.mit.edu/courses/mechanical-engineering/2-993j-introduction-to-numerical-analysis-for-engineering-13-002j-spring-2005/index.htm
2. Numerical Analysis
   https://nptel.ac.in/courses/111107062/
3. Elementary Numerical Analysis
   https://nptel.ac.in/courses/111101003/

STAT 204 Probability and Statistical Methods

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course students will be able to

- Understand the concepts of random variables, probability distributions and independence of random variables.
- Understand the meaning of probability and probabilistic experiment
- Familiarize with the all approaches to probability theory and particularly, the axiomatic approach.
- Understanding the meaning of conditional probability.
- Distinguish between independent and uncorrelated random variables.
- Distinguish between discrete and continuous random variables and be able to represent them using probability mass, probability density, and cumulative distribution function.

- Identify important types of distributions such as exponential, Binomial, Poisson, Normal, and use them as suitable models in basic science and engineering problems.
- Understand the concept of statistical hypothesis and able to solve such type of real life problems.

Section A

Basic concepts of Probability, Classical, Empirical and Axiomatic approach to Probability. Addition and Multiplication theorems of Probability. Baye's theorem and its simple applications. Marginal, Joint and Conditional probability. Mathematical Expectation: Expectation of sum & products of random variables, Variance & Covariance.

SectionB

Correlation & Regression Karl Pearson coefficient of Correlation. Partial and Multiple Correlation (upto three variables only).

Probability Distributions: Binomial, Poisson, Normal, Rectangular & Exponential distributions with simple applications. Fitting of Binomial, Poisson, and, Normal distributions.

Section C

Sampling distribution, Standard Error, Simple random sampling and stratified random sampling with their role. Test of significance for mean, variance, Proportion and correlation coefficient. Test of goodness of fit and independence of attributes. Analysis of variance with one observation per cell.

Suggested Books:

1. Johnson, R. A., Miller, I., & Freund, J. E. (2011). *Probability and Statistics for Engineers*, Prentice Hall.
2. Goon, A. M., Gupta, B. D. & M. K. Gupta.(1980). *Fundamental of Statistics*. (Vol. I & II).The World Press Pvt. Ltd. Kolkata.
3. Mood, A. M., Graybill, F. A., &Boes, D. C. (2001). *Introduction to Theory of Statistics* (3rd ed.). McGraw- Hill International.

Suggested E-Learning Material:

1. Probability and Random variables

   https://ocw.mit.edu/courses/mathematics/18-440-probability-and-random-variables-spring-2014/lecture-notes/

2. Probability and Statistics
   https://nptel.ac.in/courses/111105041/27
3. Statistical Inference
   https://nptel.ac.in/courses/111105043/

ELE 311 Analog Integrated Circuit

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Student will be able to understand the design and working of transistor amplifiers.
- Observe the effect of negative feedback on different parameters of an amplifier and different types of topologies.
- Will have the potential to build and troubleshoot analog circuits.
- Understand the fundamentals and areas of applications of integrated circuits.
- Demonstrate the ability to design practical circuits that perform the desired operations.

SECTION A

Feedback Amplifiers: Classification of amplifiers,General feedback structure, Properties of negative feedback, Feedback topologies, Transfer gain with feedback, General characteristics of negative feedback amplifiers, input resistance, output resistance, Methods of analysis: Voltage series and current series feedback, current shunt and voltage shunt feedback.

Power Amplifiers: Classification, Operation, Analysis and design of Class A, Class B, Class AB, Class C, Power dissipation and efficiency calculations, Amplifier distortion.

SECTION B

High Frequency Amplifiers: Hybrid–pi CE transistor model, Hybrid –pi conductance, Hybrid –pi capacitances, CE short circuit current gain,

Current gain with resistive load, Single stage CE transistor amplifier response, Gain bandwidth product.

Multistage Amplifier: Frequency response, Effect of cascading on bandwidth, RC coupled amplifier, Low frequency response of an RC coupled stage, Effect of emitter bypass capacitor, High frequency response of two cascaded CE transistor stages, Multistage CE amplifier cascaded at high frequencies.

SECTION C

Operational Amplifier and its applications: BJT differential amplifier: DC and AC analysis, Transfer characteristics, Differential and Common mode gain. Ideal Op-amp, inverting and non inverting amplifier, offset voltage, offset current, bias current, slew rate, CMRR, design of integrator and differentiator, summing amplifier, differential and instrumentation amplifier, Active filter, Op-amp RC oscillator circuits : Wien bridge, Phase shift. Precision rectifier, comparator, Schmitt trigger and 555 IC Timer.

Text Books:

1. Millman, J., Halkias, C. & Parikh, C. (2017*). Integrated Electronics* (2nd ed.). McGraw Hill Education.
2. Boylestad&Nashelsky, (2015). *Electronic Devices and Circuit Theory*(11th ed.). Pearson Education India.
3. Gayakwad R. A. (2010). *OP-AMP and linear integrated circuits* (4th ed.). New Delhi: Prentice Hall.

Reference Books:

1. Sedra, A. & Smith, K. (2009). *Microelectronic Circuits: Theory and Applications* (5th ed.). Oxford University Press.

e-Resources:

1. https://nptel.ac.in/courses/117106030/
2. https://nptel.ac.in/courses/117106030/nptel-aic/analogicdesign-intro.pdf
3. https://www.analog.com/en/education/education-library/tutorials/analog-electronics.html
4. https://nptel.ac.in/courses/117106030/nptel-aic/analogicdesign-intro.pdf
5. https://onlinecourses.nptel.ac.in/noc18_ec05/preview

6. https://nptel.ac.in/syllabus/117106030/
7. https://www.electronics-tutorial.net/analog-integrated-circuits/
8. https://www.allaboutcircuits.com/textbook/experiments/chpt-6/introduction-analog-integrated-circuits/

ELE 301L Analog Integrated Circuit Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Develop the skill to build, and troubleshoot Analog circuits.
- Student will be able to choose the appropriate integrated circuit modules to build a given application.
- Evaluate possible causes of discrepancy in practical experimental observations in comparison to theory.
- Examine the appropriate integrated circuit modules to build a given application

LIST OF EXPERIMENTS

1. To design the AstableMultivibrator using 555.
2. To design the MonostableMultivibrator using 555.
3. To design summer using 741 IC.
4. To design Integrator using 741 IC.
5. To design Schmitt Trigger using 741 IC.
6. To design Differentiator using 741 IC.
7. To design peak detector using 741 IC.
8. To design scalar using 741 IC.
9. To study Active Filters: LPF,HPF,BPF.
10. To design Voltage to frequency converter
11. To design phase locked loop.
12. To study frequency shift keying using PLL 565.

ELE 509 Microprocessors and Microcontrollers

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Analyze the architecture, programming and interfaces for higher versions of Microprocessor like 80286, 80386, Pentium.
- Evaluate the detailed working of microprocessor based computers and development boards.
- Implement the interfacing of peripheral devices with Microprocessor base in real time projects
- Utilize the architecture, programming and interfacing skills to build projects using Microcontroller 8051
- Understand the concepts of industrial and real time embedded system applications.

Section A

8086/8088 Microprocessor: Pin Assignment, Architecture, Functional Diagram, Register Organization, Memory address space & data organization, Segment registers & Memory segmentation, Dedicated & general use of memory,

Addressing modes, Instructions,Functional schematic, Minimum and Maximum mode operations of 8086,

8086 Control signals interfacing, Timing Diagrams, Interrupts, Bus timings, Demultiplexing.

Assembly Language Programming of 8086: Instruction Format, Instruction Set, Data Transfer instructions, Arithmetic instructions, Logical instruction, Shift instructions, Rotate instructions, Flag control instructions, Compare instructions, Jump instructions, Subroutine & the subroutine handling instructions, Loop & loop handling instructions, String instructions.

Section B

Peripheral Devices and Their Interfacing:Introduction, memory and I/O interfacing with 8086, data transfer schemes, programmable peripheral interface (8255), programmable DMA controller (8257), programmable interrupt controller (8259), programmable communication interface (8251), programmable counter/interval timer (8253 and 8254), special purpose interfacing devices, elements and circuits for interfacing.

Communication Interface: Serial Communication Standards, USART Interfacing RS-232, IEEE-488, 20mA Current Loop, Prototyping and Troubleshooting, Software Debugging tolls, MDS.

Section C

Introduction to Microcontrollers: Overview of 8051 Micro Controller, Architecture, I/O ports and Memory Organization, Addressing modes and Instruction set of 8051,

Simple Programs using Stack Pointer, Assembly language programming. 8051

Interrupts Communication: Interrupts, Timer/Counter and Serial Communication, Programming Timer Interrupts, Programming External H/W interrupts, Programming the serial communication interrupts, Interrupt Priority in the 8051, Programming 8051 Timers, Counters and Programming.

Interfacing & Industrial Applications: Applications of Micro Controllers, Interfacing 8051 to LED's, Push button, Relay's and Latch Connections, Keyboard Interfacing, Interfacing Seven Segment Display, ADC and DAC Interfacing.

Text books:

1. Ayala, K. J. (2007). The 8051 Micro Controller Architecture, Programming and Applications (3rd. ed.). Thomson Publishers.
2. Hall,D.V. (2005). *Micro Processor and Interfacing*. Tata McGraw-Hill.

Reference books:

1. Deshmukh, A. V. (2005).*Microcontroller's theory applications*. Tata McGraw Hill.
2. Bhurchandi, K.M. & Ray, A.K. (2017). *Advanced Micro Processors*. Tata McGraw Hill.

3. Ayala, K. J. (2005). *The 8086 Micro Processors Architecture, Programming and Applications* (3rd. ed.). Thomson Publishers.
4. Carr, J. J. (2003). *Elements of Electronic Instrumentation & Measurements*. Pearson Education India.
5. Placko, D.(2007). *Fundamentals of Instrumentation and Measurements.* ISTE Ltd.

e-Resources:

1. https://swayam.gov.in/course/4446-microprocessors-and-microcontrollers
2. https://nptel.ac.in/courses/108105102/53
3. https://nptel.ac.in/courses/108105102/7
4. https://onlinecourses.nptel.ac.in/noc19_ee11/preview
5. https://nptel.ac.in/courses/Webcourse-contents/IIT KANPUR/microcontrollers/micro/ui/TOC.htm
6. https://nptel.ac.in/downloads/108105102/
7. https://nptel.ac.in/courses/106108100/

ELE 306L Microprocessors and Microcontrollers Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Develop syntax based programming skills for Microprocessor and Microcontroller based projects.
- Understand the instructions and register organization of 8086 Microprocessor programming.
- Create arithmetic, logical and functional programming for Microprocessor
- Perform emulations using and to use and develop 8086 programs.

LIST OF EXPERIMENTS

1. Write a program to calculate the addition of 16-bit Number.

2. Write a program to calculate the addition of 32-bit Number.
3. Write a program totransfer the content of one memory location to other memory location.
4. Write a program to exchange the content of one memory location to other memory location.
5. Write a program tofind out the maximum of N given numbers.
6. Write a program to generate the Fibonacci Series.
7. Write a program tofind location of given numbers.
8. Write a program to find out the multiplication of two 16-bit numbers.
9. Write a program to find out the minimum of N given numbers.
10. Write a program in 8051 to copy a block of 10 bytes from RAM location starting at 37h to RAM location starting at 59h.
11. Write a program in 8051 for addition of first 10 natural numbers
12. Write a program in 8051 for addition of two 16-bit numbers.
13. Write a program in 8051 using Timer0 to create a 10 kHz square wave on P1.0

EIE 308 Industrial Instrumentation

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Explain and identify various kinds of sensors and transducers employed in different types of industrial environments.
- Select and apply a suitable sensor for a given strain and pressure measurement application.
- Define the principle of working of various sensors used for temperature, level and flow rate measurement.
- Signify the importance of velocity and vibration measurement in standard industrial testing procedures.

- Understand and analyze a virtual instrument employed for a particular application.

Section A

Role of transducers in instrumentation- classification of transducer and its characteristics. Signal Conditioning of Strain Gauge circuits, temperature compensation for Strain gauge, Piezoelectric Transducers and its Frequency response. Optical Transducers: Photo emissive cell, Photo voltaic cell, Photo Conductive cell.

Pressure Measurement: Manometers, Elastic pressure elements, Electromechanical Pressure Transducers, Vacuum Measurement: Knudsen gauge, Pirani Gauge, Ionization gauge, McLeod Gauge.

Noise: Electrical noise, Static noise, Magnetic noise, Crosstalk and its remedies.

Section B

Temperature Measurement: Thermometers: Liquid in glass and Bimetallic type, Radiation Pyrometers and Optical Pyrometers.

Level Measurement: Sight Glass, Hydrostatic, Purge type level sensor, differential pressure method for level measurement, Buoyancy methods, Nucleonic level gauge, Ultrasonic level meter, and capacitive type level sensor.

Flow measurement: Venturimeter, Orifice plate, Pitot tubes, Rotameter, Turbine Flowmeter, Electromagnetic Flowmeter, Hot wire anemometer, Ultrasonic Flowmeter, Laser Doppler anemometer.

Section C

Measurement of Velocity: DC and AC Tacho-generators, Seismic Transducer for vibration measurement, Accelerometers.

Miscellaneous Measurement: pH Sensor, hygrometer, measurement of thermal conductivity and thickness, Hydrometer.

Virtual Instrumentation: Architecture of a virtual Instrumentation, graphical system design, Data-flow techniques, graphical programming in data flow and comparison with conventional programming.

Text Books:

1. Sawhney, A. K. (2015). *A Course in Electrical and Electronic Measurements and Instrumentation*. Dhanpat Rai Publication.
2. Jain, R.K. (2015). *Mechanical and Industrial Measurements*. Khanna Publishers.
3. Nakra, B.C. & Chaudhry, K.K. (2016). *Instrumentation, Measurement and Analysis* (4th ed.). Tata McGraw Hill.

Reference Books:

1. Doebelin, E. O. (1990). *Measurement Systems: Application and Design* (4th ed.). Mcgraw Hill International.
2. Eckmann, D. P. (2006). *Industrial Instrumentation*. CBS Publishers and Distributors.
3. Kalsi, H.S. (2017). *Electronic Instrumentation* (3rd ed.). Mcgraw Hill Education.
4. Singh, S.K. (2017). *Industrial Instrumentation and Control* (3rd ed.). Mcgraw Hill Education.
5. Rangan, C., Sharma, G. & Mani, V.S.V. (2017*). Instrumentation: Devices and systems* (3rd ed.). Mcgraw Hill Education.

e-Resources:

1. https://nptel.ac.in/courses/112103174/3
2. https://swayam.gov.in/course/3764-industrial-instrumentation
3. https://online.stanford.edu/courses/me220-introduction-sensors

EIE 308L Industrial Instrumentation Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Employ built-in functions in LabVIEW to solve various numerical problems.

- Develop Vis for solving problems involving different types of mathematical models and equations.
- Solve many simulation problems encountered in theory courses of the semester.
- Perform simulations using LabVIEW and develop optimization toolkits for various electrical and electronics engineering problems.
- Design and simulate projects for electrical and electronics engineering problems.

LIST OF EXPERIMENTS

1. Introduction to LabVIEW environment.

2. Application of arithmetic, logical and Boolean operations in LabVIEW.

3. Implement a virtual instrument (VI) for conversion of temperature from Celsius to Fahrenheit.

4. Develop a VI in LabVIEW to solve an equation using Formula Node.

5. Create a VI to compute full adder logic using half adder logic as sub VI.

6. Application of 'For' and 'While' loop using LabVIEW.

7. Create a VI to find the factorial of the given number using 'For' Loop and Shift Registers.

8. Create a VI to display any information using case structure.

9. Introduction of array and cluster.

10. Introduction to NI ELVIS and its application to component testing.

11. Implementation of clipper and potential divider circuit using ELVIS.

12. Implement a RC circuit on NI ELVIS and acquire the data for charging and discharging period.

13. Implement an event counter using photo interrupter (1A57HR) on NI ELVIS and also implement a VI to display the counting.

14. Interface LDR using NI ELVIS and implement a VI to glow an LED when LDR senses the change in light intensity.

EIE 309 Linear Control System

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	3	1	0	4

Learning Outcomes

The Students will be able to:

- Design and implement feedback control scheme for any industrial process.
- Identify and utilize the various components employed in control systems.
- Design and apply the control scheme for controlling any plant under consideration.
- Utilize various types of frequency domain approaches in the development of a control scheme for complex dynamic process.
- Apply the compensation techniques and modern control approaches in design and analysis of control systems.

Section A

Introduction to control system, differential equation and LTI transfer function, Mathematical Modeling, Block diagram reduction techniques, signal flow graph, servomechanism: synchros, AC and DC servomotors.

Time Domain Analysis: Standard test signals, Time Response Analysis of First Order and Second Order System. Transient response analysis, steady state errors and error constants.

Section B

Introduction to controllers: P, PI, PD and PID controllers, effect of feedback, Stability concept, relative stability, Routh stability criterion.

Root Loci Technique: Concept of root locus, construction of root locus and closed loop stability.

Frequency Domain Analysis: Correlation between time & frequency response, Polar plots, Stability in frequency domain (GM & PM), Nyquist plots and Nyquist stability criterion, Constant M and N circles.

Section C

Bode plot, Performance specifications in frequency-domain. Compensation: cascade and feedback compensation, time & frequency domain design using lag, lead and lag-lead compensation,

State Space Analysis:

Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability.

Text Books:

1. Ogata, K. (1996). *Modern Control Engineering*. USA, Upper Saddle River, NJ: Prentice-Hall
2. Kuo, B.C. &Golnaraghi, F. (2003). *Automatic controlsystem*(8th ed.). Asia: John Wiley and Sons.
3. Gopal, M. (2002). *Control System: Principles and Design* (3rd ed.). TMH.

e-Resources:

1. https://swayam.gov.in/courses/4776-july-2018-control-systems
2. https://www.udemy.com/control-systems/
3. https://nptel.ac.in/courses/108101037/
4. https://studentshubblog.files.wordpress.com/2014/12/modern-control-engineering-3rd-ed-ogataprentice-hall.pdf
5. https://pdfstores.files.wordpress.com/2017/01/kuo-automaticcontrolsystems.pdf
6. https://onlinecourses.nptel.ac.in/noc18_ee41
7. https://nptel.ac.in/courses/108106098/
8. https://nptel.ac.in/downloads/108103008/
9. http://www.mediafire.com/file/aqkq47e1el3hri7/Control+System+Engineering-+Norman+S.+Nise.+6th+Edition.pdf
10. https://drive.google.com/file/d/0B2KoaKB1FMGjUHNXdlZvSFhUMmM/edit

EIE 309L Linear Control System Lab

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	2	1

Learning Outcomes

The Students will be able to:

- Able to use and design the control schemes for various industrial processes.
- Capable to identify and employ various filters and compensators utilized in control system design.
- Apply many built-in functions in MATLAB to solve numerical problems
- Develop code for solving problems involving different types of mathematical models and equations.

LIST OF EXPERIMENTS

1. Operation and error calculation of the transmitter-receiver pair as a simple open loop position control system.
2. To obtain open and closed loop response of various process configurations.
3. To attain open loop and closed loop speed control of DC motor.
4. Step response studies for various values of forward gain during position control of DC motor.
5. To perform time domain analysis of first and second order systems using linear system simulator.
6. To study potentiometer as an error detector.
7. Identification of the oven parameters and study of P, PI, and PID based temperature control of oven.
8. To study high pass, low pass, band pass & band stop filter.
9. To study lead lag compensator.

MATLAB based experiments:

10. To obtain transfer function of a system defined in pole-zero form.
11. To find overall transfer function of a system comprise of series and parallel combinations of plants.

12. To find closed loop transfer function from the given block diagram and draw its pole-zero plot.
13. To plot step and impulse response of first and second order control system.
14. To obtain root locus, Nyquist plot and bode plot for the given transfer function.

MCTR 305 Robotics and Control

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Develop skills of creating industrial and mobile robot projects
- Implement robots like KUKA, PUMA in real industrial world
- Create innovative robot designs using mathematical concepts of kinematics
- Develop autonomous mobile robots in surveillance, security, home and office services.

Section A

Introduction to Robotics: Definition and Evolution of Robots, Laws of Robotics, Anatomy and Classification of Robots, Human Arm verses Robotic Arm, its Manipulation and Control.

Coordinate Frames: Translated and Rotated Frames, Mapping between Translated and Rotated Frames, Transformation of Vectors, Composite Homogeneous Transformation Matrix, Fixed Angle(RPY) and Euler Angle (WVU, ZYZ) Representation.

Robot Kinematics: Kinematic Modeling of the Manipulator, Denavit-Hartenberg (D-H) Notation, Forward (Direct) Kinematics and Inverse Kinematics Model, Kinematics of typical manipulators (2-DOF, Cylindrical arm, Articulated arm, SCARA, Stanford,PUMA-560), Solutions of inverse Kinematic problems.

Section B

Differential Transformation: Linear and angular velocity, relationship between transformation matrix and angular velocity, velocity propagation, Jacobian Manipulator, Jacobian Inverse and singularity, Static analysis (force and momentum equilibrium),

Dynamic Modeling: Lagrange-Euler formulation, computation of Inertia (KE, PE and EOM) and Newton-Euler formulation of 2-DOF planar manipulator.

Section C

Trajectory Planning: Terminology, Steps in Trajectory Planning, Joint Space Techniques, Cartesian Space Techniques, Joint-Space Versus Cartesian Space Trajectory Planning.

Control of Manipulators: Open-and closed-loop control, manipulator control problem, linear control schemes, characteristics of second-order linear system, linear second-order SISO model of manipulator joint, joint actuators, partitioned PD control scheme PID control scheme, computer torque control.

Text books:

1. Groover, M. P. (2017). *Industrial Robotics: Technology, Programming, and Applications*(2nd ed.). Pearson Education.
2. Niku, S. B. (2011). *Introduction to Robotics* (2nd ed.). Wiley.
3. Fu, K.S., Lee, C.S. G. &Gonzalez, R. (1987) . *Robotics: Control, Sensing, vision and intelligence*. Tata McGraw-Hill Education
4. Mittal, R. K. & Nagrath, I. J.(2018). *Robotics and Control*. Tata McGraw-Hill Education.

References books:

1. Craig, J. J. (2008). *Introduction to Robotics: Mechanics and Control* (3rd ed.). Pearson Education.
2. Spong, M. W. & Vidyasagar, M. (2008). *Robot Dynamics and Control*. John Wiley & Sons.
3. Siciliano , B. & Sciavicco, L. (2010). *Robotics: Modelling, Planning and Control*. Springer.

e-Resources:

1. https://nptel.ac.in/courses/112101099/

2. https://www.edx.org/course/robotics-1
3. https://www.coursera.org/specializations/robotics
4. https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2005/
5. https://www.edx.org/course/robotics-dynamics-control-pennx-robo3x
6. https://onlinecourses.nptel.ac.in/noc18_me61/preview
7. https://swayam.gov.in/courses/4859-july-2018-robotics
8. https://www.edx.org/learn/robotics
9. https://www.coursera.org/specializations/robotics

MCTR 305L Robotics and Control Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Develop skills of creating industrial and mobile robot projects
- Implement robots like KUKA, PUMA in real industrial world
- Create innovative robot designs using mathematical concepts of kinematics
- Develop autonomous mobile robots in surveillance, security, home and office services.

LIST OF EXPERIMENTS

1. Implementation of D-H Parameters on Robo Analyzer software.
2. Implementation of Forward Kinematics on Robo Analyzer Software.
3. Implementation of Inverse Kinematics on Robo Analyzer Software.
4. Implementation and study of KUKA-Sim simulator/HMI Interface.
5. Implementation on Hardware (KR-16).
6. Implementation of Sensor Fusion on Robotino Software and hardware.
7. Implementation of Path Tracking on Robotino Software and hardware.
8. Study of TAL BRABO Robot with practical implementation.

EEE 308 Power Electronics

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	3	1	0	4

Learning Outcomes

The Students will be able to:

- Analyze functioning of switching devices for various applications
- Operate the switches in series and parallel, protect the switches and apply commutation techniques for different circuits
- Analyze and design phase controlled rectifiers and their performance
- Implement of voltage regulators and cyclo-converters
- Design of inverter circuits

Section A

Need of power electronics, introduction to power electronics devices (static and dynamic characteristics) power diodes, power transistor, power MOSFETS, IGBT, MCT, GTOs and TRIAC. **Thyristor (SCR):** Operational characteristics turn on methods, switching characteristics, protection, over voltage protection, over current protection, gate protection, Snubber circuit firing circuits, heating, series and parallel combination of Thyristors.

Section B

Commutation Techniques: Load commutation, resonant- pulse commutation complementary commutation, impulse commutation, line commutation, **Phase controlled rectifier:** Principle of phase control, single and three phase converters, effect of source impedance on the performance of converters dual converter (ideal and practical) **DC choppers:** Principle, control strategies, step-up and step-down choppers.

Section C

Inverters: Single-phase voltage source inverters 180 and 120 mode operation, Fourier analysis of single-phase inverter output voltage, pulse width modulated inverters, reduction of harmonics in the inverter output, single phase current source inverters with ideal switch. **Cyclo-converters:** Step-up and step-down cyclo-converter, Single phase to single-phase cyclo-converters three-phase half wave cyclo-converters.

Text Books

1. Rashid, M. H. (2017). *Power Electronics Circuits Devices and Applications* (4th ed.). PHI Publication
2. Bimbhra,P.S. (2012). *Power Electronics* (5th ed.).Khanna Publication.
3. Singh,M. D. &Khanchandani,K. B (2013). *Power Electronics* (2nd ed.). McGraw Hill.

Reference Books:

1. Moorthy, R. (1991). *An Introduction To Thyristors And Their Application* (2nded.).Affiliated East-West Press.
2. Sen,P.C. (2005). *Modern Power Electronics* (2nd ed.). S.Chand Publisher.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc19_ee03/preview
2. https://www.coursera.org/specializations/power-electronics
3. https://swayam.gov.in/courses/5440-jan-2019-fundamental-of-power-electronics
4. https://swayam.gov.in/courses/5435-jan-2019-advance-power-electronics-and-control
5. http://minitorn.tlu.ee/~jaagup/kool/java/kursused/15/robootika/elektriopik.pdf
6. http://down.elechu.com/Power%20Electronics/PEmohan(2nd).pdf
7. http://down.elechu.com/Power%20Electronics/PE3rdmohan.pdf
8. http://u.dianyuan.com/bbs/u/51/1173964035.pdf
9. http://dl.offdownload.ir/ali/Power%20Electronics,Daniel%20W.%20Hart.pdf
10. https://edisciplinas.usp.br/pluginfile.php/2587319/mod_resource/content/2/Introduction_to_Solid_State_Power_Electronics_Powerex.pdf
11. https://onedrive.live.com/?cid=7BCEF2CD3680B4A0&id=7BCEF2CD3680B4A0%21212&parId=7BCEF2CD3680B4A0%21124&o=OneUp
12. https://nptel.ac.in/courses/108105017/

EEE 304L Power Electronics Lab

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	2	1

Learning Outcomes

The Students will be able to:

- Analyze functioning of switching devices
- Implement triggering circuit
- Apply appropriate commutation technique
- Analyze and design phase controlled rectifiers and their performance
- Design of cyclo-converters

LIST OF EXPERIMENTS

1. To draw the V-I characteristics of DIAC.
2. To draw the V-I characteristics of SCR.
3. To draw the V-I characteristics of TRIAC.
4. To draw the input and output characteristics of IGBT.
5. To draw the firing angle and output voltage of SCR triggering circuit.
6. To obtain the time delay of UJT controlled thyristor firing circuit.
7. To implement the communication technique of SCR.
8. To draw the output voltage and current of inverter using MOSFET.
9. To obtain the ripple factor of single phase half and full wave rectifier.
10. To obtain the output frequency of cyclo-converter using R and RL load.

EIE 307 Industrial Automation

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes

The Students will be able to:

- Identify and employ the various components of Industrial automation to provide automated solution of given problem.

- Implement and deploy Programmable Logic Controller programs for industrial application.
- Design Supervisory Control and Data Acquisition based monitoring and control application for industrial system.
- Operate and understand the distributed control system utilized in process industries.
- Understand and analyze the various data communication links and protocols.

Section A

Introduction to Automation and its Components: Relays- electro mechanical relays, reed relays, hermetically sealed relay, solid state relay. Contactors, Switches- toggle switch, DIP switch, Rotary switch, Selector switch, Pushbutton, Limit Switch, Temperature switch, Pressure switch, Level switch, Flow switch, Actuators.

Section B

Programmable Logic Controller (PLC) : Introduction, Architecture, Selection criteria, I/O modules, Introduction to various programming techniques, Ladder diagram programming, Bit Instructions, Timers, Counters, Sequencers, mathematical and logical instructions, types of memory, real time applications.

Section C

Supervisory Control and Data Acquisition (SCADA): Introduction, Elements of SCADA, Features of SCADA, Applications of SCADA system.

Distributed Control System (DCS): Centralized and Distributed Control Concept, Specifications of DCS, System Architecture, Elements of DCS, DCS Displays (User defined displays, Graphic Display, Trend Display, Alarm summary, Instrument faceplate, tuning display).Advantages and Applications of DCS.

Data Communication Links and Protocols: HART Protocol, Field Bus, Comparison of MODBUS, PROFIBUS, FIPBUS, Industrial Ethernet.

Text Books:

1. Killian, C.T. (2006). *Modern Control Technology, Components and Systems* (2nd ed.). Cengage Learning.

2. Lukcas,M.P. (1986). *Distributed Control Systems*. New York: Van Nostrand Reinhold Co.
3. Webb, J.W. &Reis,R. A. (2003). *Programmable Logic Controller-Principles and Applications* (4th ed.), New Jersey:PHI.

Reference Books:

1. Petruzella,F. D. (2010).*Programmable logic controller* (4th ed.). New York: McGraw Hill.

e-Resources:

1. https://nptel.ac.in/courses/108105062/18
2. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-06-principles-of-automatic-control-fall-2012/
3. https://www.coursera.org/lecture/intelligent-machining/programmable-logic-controllers-plc-fGz3r
4. https://nptel.ac.in/courses/112102011/11
5. https://nptel.ac.in/courses/112103174/3
6. https://nptel.ac.in/courses/108105062/37
7. https://swayam.gov.in/course/1395-industrial-automation-and-control

EIE 307L Industrial Automation Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Programming of Siemens Programmable Logic Controllers and other Programmable Logic Controllers with similar specifications.
- Design and deploy Programmable Logic Controller programs using timers and counters.
- Design applications based on logic and arithmetic operations using Programmable Logic Controllers.
- Implement the various real life applications using Programmable Logic Controllers.

LIST OF EXPERIMENTS

Programmable Logic Controller: Siemens S7-1200 & Mode of Programming: Ladder Logic

1. Introduction to S7-1200 and its configuration procedure.
2. Implementation of basic logic gates.
3. PLC based Ladder logic programming using NO/NC Switches.
4. Applications of soft timers in controlling of industrial operations.
5. Applications of counters for real-time event counting.
6. Write a program for blinking of LEDs.
7. Introduction to arithmetic operations in industrial applications.
8. Implementation to logical operations in industrial applications.
9. Write a ladder logic program for control of traffic light.
10. Designing of a digital clock using ladder logic programming.

EEE 309 Power System-I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Understand generation of electric power and calculate transmission line parameters
- Analyze the performance of short, medium and long transmission lines
- Identify pin, post and suspension insulators
- Estimation of string efficiency and mechanical design of overhead transmission lines
- Understand corona effect, electromagnetic interference with communication lines and travelling waves
- Implementation of insulated cables, distribution system, and voltage and frequency control methods.

Section A

Introduction to power system. Generation of electrical energy- thermal, hydro and nuclear power plants. Load curves and factors, Electricity tariffs.

Transmission: types of conductor, resistance of line, skin effect, Proximity effect, Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit transmission lines, Representation and performance of short, medium and long transmission lines, Ferranti effect. Surge impedance loading.

Types of insulators, Voltage distribution across an insulator string, string efficiency, grading and methods of improving string efficiency.

Section B

Mechanical Design of Overhead Transmission Lines- Catenary Curve, Calculation of Sag and Tension, Effects of wind and ice loading, sag template, Vibration dampers.

Corona and Interference- Phenomena of Corona, Corona formulation, Calculation of Potential Gradient, Corona loss, Factors affecting Corona, Methods of reducing Corona and Interference, Electrostatic and Electromagnetic Interference with Communication lines.

Traveling Waves- Wave equation for uniform Transmission lines, velocity of propagation, surge impedance, reflection and transmission of traveling waves under different line loadings. Bewlay's lattice diagram, protection of equipments and line against traveling waves.

Section C

Insulated cables: Type of cables and their construction, dielectric stress, grading of cables, insulation resistance, capacitance of single phase and three phase cables, dielectric loss, heating of Cables.

Distribution Systems: Primary and secondary distribution systems, feeder, distributor and service mains. Radial and ring- main distribution systems, Kelvin's law.

Voltage and Load Frequency Control: Introduction to control of active and reactive power flow, control of voltage, Introduction to Load Frequency Control and Automatic generation control.

Text Books:

1. Stevenson, W. D. (2002), "*Element of Power System Analysis*"(2nd Edn.) McGraw Hill, USA.

2. Wadhwa, C. L. (2016), "*Electrical Power Systems*"(7thEdn.) New age international Ltd. Third Edition.
3. Deshpande, M. V. (2011), "*Electrical Power System Design*" (1stEdn.), PHI.

Reference Books:

1. Soni, Gupta & Bhatnagar (2009), "*A Course in Electrical Power*", (1stEdn.) Dhanpat Rai & Sons, India
2. Uppal, S. L (1987), "*Electric Power*", (15thEdn.) Khanna Publishers, India
3. Singh, S. N., (2011) "*Electric Power Generation, Transmission & distribution*" (2ndEdn.), PHI

e-Resources:

1. https://drive.google.com/file/d/0B15qSPkgb-zRY216X1NPa1dlWUU/view
2. http://jfgieras.com/Grigsby_Chapter_34_LEM.pdf
3. http://down.elechu.com/stability/Book.pdf
4. https://nemasumit.files.wordpress.com/2017/08/electrical-power-engineers-handbook.pdf
5. https://nemasumit.files.wordpress.com/2017/08/electrical-machines-drives-and-power-systems-5e.pdf
6. https://docs.google.com/file/d/0B5vXY4-Kg5GeN19FVjNvVXZlTjg/edit
7. https://pdfstores.files.wordpress.com/2016/04/modern-power-system-analysis_d-p-kothari-and-i-j-nagrath.pdf
8. https://nptel.ac.in/courses/108105017/

EEE 309L Power System-I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Perform various arithmetic and matrix operations in MATLAB

- Implement MATLAB commands, control operators
- Calculation of various problems using MATLAB programming
- Design electrical circuits using MATLAB simulink
- Estimate power system parameters using MATLAB programming

LIST OF EXPERIMENTS

1. Acquaintance with MATLAB.
2. Various matrix operations, logical operations and loop statements using MATLAB.
3. Study of various plot commands in MATLAB.
4. Transient analysis of series RL and RC circuit.
5. Generation of basic signals (Impulse, Step, Ramp *etc*.) using Simulink
6. Calculate the inductance and capacitance of different type of transmission line configuration
7. Calculation of Vs, Vr, line losses and power factor of short transmission line.
8. Calculation of Vs, Vr, line losses and power factor of medium transmission line.

EEE 307 Electrical Machines-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Develop various types of models used for synchronous machines like, hydro, steam turbine, governors & excitation systems
- Understand the construction, connections, principle of operation of three-phase & single phase induction motor
- Understand equivalent circuits representation of three phase & single phase induction motor

- Understand calculation of the performance characteristics (current/speed and torque/speed) of the three-phase & single phase induction motor
- Understand the starting and speed control methods of three-phase induction motor
- Understand the construction, connections, principle of operation of single-phase induction and special purpose motors
- Perform tests on synchronous and induction machines

Section-A

Synchronous Machine I*:* Constructional features, Armature winding, EMF Equation, Winding coefficients, equivalent circuit and phasor diagram, Armature reaction, O. C. & S. C. tests, Voltage Regulation using Synchronous Impedance Method, MMF Method, Potier's Triangle Method, Parallel Operation of synchronous generators, operation on infinite bus, synchronizing power and torque co-efficient **Synchronous Machine II:** Two Reaction Theory, Power flow equations of cylindrical and salient pole machines, operating characteristics **Synchronous Motor***:* Starting methods, Effect of varying field current at different loads, V- Curves, Hunting & damping, synchronous condenser

Section-B

Three phase Induction Machine – I: Constructional features, Rotating magnetic field, Principle of operation, Phasor diagram, equivalent circuit, torque and power equations, Torque- slip characteristics, no load & blocked rotor tests, efficiency, Induction generator & its applications.**Three phase Induction Machine- II:** Starting, Deep bar and double cage rotors, Cogging& Crawling, Speed Control (with and without emf injection in rotor circuit.)

Section-C

Single phase Induction Motor*:* Double revolving field theory, Equivalent circuit, No load and blocked rotor tests, Starting methods, repulsion motor **AC Commutator Motors***:* Universal motor, Single phase AC series compensated motor, stepper motors

Text Books:

1. Nagrath, I. J. &Kothari, D. P. (2017), "*Electrical Machines*" (3rdEdn.), Tata McGraw Hill.

2. Ashfaq , H. (2016), "*Electrical Machines*" (5thEdn.), Dhanpat Rai & Sons.
3. Fitggerald, A. E., Kingsley Jr., C. and Umans (2009), "*Electric Machinery*" (6thEdn), McGraw Hill, International Student Edition.
4. Gupta, B. R. &Singhal, V. (2005) "*Fundamentals of Electrical Machines*" (3rdEdn.), New Age International.

Reference Books:

1. Kosow, I. L. (2009), "*Electric Machine and Transformers*" (2ndEdn.), Prentice Hall of India.
2. Say, M. G. (2005), "*The Performance and Design of AC machines*" (4thEdn.), Pit man & Sons.
3. Guru, B. S. and Hizirogulu, H. R. (2001) "*Electric Machinery and Transformers*" (3rdEdn.), Oxford University Press.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc19_ee01
2. https://nptel.ac.in/courses/108106071/
3. https://nptel.ac.in/courses/108105017/
4. https://eleccompengineering.files.wordpress.com/2014/08/stephen_chapman_electric_machinery_fundamentalsbookfi-org-1.pdf
5. http://solidviews.com/OaOY
6. https://kahrbjy.files.wordpress.com/2012/08/principles-of-electric-machines-solution-manual.pdf

EEE 301L Electrical Machines-II Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Understand calculation of the performance characteristics (current/speed and torque/speed) of the three-phase & single phase induction motor

- Understand the starting and speed control methods of DC motor
- Understand the construction, connections, principle of operation of transformer
- Perform tests on DC and induction machines

LIST OF EXPERIMENTS

1. Perform no load test in a single phase induction motor.
2. Obtain the losses and efficiency of DC shunt machine by Hopkinson's test.
3. Obtain the efficiency and losses of DC machine by Swinburne's test.
4. Perform load test of single phase IM.
5. To perform Sumpner's test of single phase transformer.
6. Study of cut section model of single and three phase Induction motor.
7. Speed control of compound DC motor.
8. To study compound motor-generator set.

EEE 310 Power System-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Model various power system components (synchronous machine, transformer, transmission line) and representation of 3 phase system using per unit system & symmetrical components
- Calculate and analyze the symmetrical and unsymmetrical faults in power system
- Solve load flow/power flow problems on transmission line with various analysis methods and interpret the result
- Analyse transient and steady state stability for power system
- Determine the economic schedule of thermal generators

Section A

Representation of Power System Components: Synchronous machines, Transformers, Transmission lines, One line diagram, Impedance and reactance diagram, per unit System.

Symmetrical components and fault analysis: Symmetrical Components of unbalanced phasors, power in terms of symmetrical components, sequence impedances and sequence networks. Transient in R-L series circuit, calculation of 3-phase short circuit current and reactance of synchronous machine, internal voltage of loaded machines under transient conditions.

Section B

Unsymmetrical faults: Analysis of single line to ground fault, line to line fault and Double Line to ground fault on an unloaded generators and power system network with and without fault impedance. Formation of Z bus using singular transformation and algorithm, computer method for short circuit calculations.

Load Flows: Introduction, bus classifications, nodal admittance matrix (Y BUS), development of load flow equations, load flow solution using Gauss Siedel and Newton-Raphson method, approximation to N-R method, line flow equations and fast decoupled method.

Section C

Power System Stability: Stability and Stability limit, Steady state stability study, derivation of Swing equation, transient stability studies by equal area criterion and step-by-step method. Factors affecting steady state and transient stability and methods of improvement.

Economic Operation of Power Systems: Introduction, Input output, heat rate and incremental rate curves of thermal generating units, Distribution of loads between units within a plant, Transmission loss equation, Classical Economic dispatch with losses.

Text Books:

1. Stevenson, W. D. (2002). *Element of Power System Analysis*(2nd Edn.).McGraw Hill, USA.
2. Wadhwa, C. L. (2016). *Electrical Power Systems*(7th Edn.) New age international Ltd. Third Edition.

3. Deshpande, M. V. (2011). *Electrical Power System Design* (1st Edn.). PHI.

Reference Books:

1. Soni, Gupta & Bhatnagar (2009). *A Course in Electrical Power* (1st Edn.).Dhanpat Rai & Sons, India
2. Uppal, S. L (1987). *Electric Power*(15th Edn.).Khanna Publishers, India
3. Singh, S. N., (2011) "*Electric Power Generation, Transmission & distribution*" (2nd Edn.), PHI

E-Resources:

1. https://nptel.ac.in/courses/108105067/
2. https://nptel.ac.in/courses/108102047/
3. https://nptel.ac.in/courses/108105104/
4. https://onlinecourses.nptel.ac.in/noc19_ee02
5. https://drive.google.com/file/d/0B15qSPkgb-zRY216X1NPa1dlWUU/view
6. http://jfgieras.com/Grigsby_Chapter_34_LEM.pdf
7. http://down.elechu.com/stability/Book.pdf
8. https://nemasumit.files.wordpress.com/2017/08/electrical-machines-drives-and-power-systems-5e.pdf
9. https://pdfstores.files.wordpress.com/2016/04/modern-power-system-analysis_d-p-kothari-and-i-j-nagrath.pdf

EEE 310L Power System-II Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Model various power system components (synchronous machine, transformer, transmission line) and representation of 3 phase system using per unit system & symmetrical components

- Calculate and analyze the symmetrical and unsymmetrical faultsin power system
- Solve load flow/power flow problems on transmission line with various analysis methods and interpret the result
- Analyse transient and steady state stability for power system
- Determine the economic schedule of thermal generators

LIST OF EXPERIMENTS

1. To plot the instantaneous current, active and reactive power for a given load with power factor over the interval 0 to 2π.
2. To formulate bus admittance (Y-BUS) matrix using node equation method.
3. To formulate bus admittance (Y-BUS) matrix using singular transformation.
4. To solve non-linear equation using Gauss-Seidel and Newton Raphson method.
5. To solve load flow problem using Gauss-Seidel.
6. To solve load flow problem Newton Raphson method.
7. To obtain short-circuit parameters for symmetrical faults.
8. To perform unsymmetrical fault analysis
9. To perform transient stability analysis of single machine connected to infinite bus system.
10. To obtain numerical solution of Swing equation using step-by-step method.
11. Software will used: MATLAB, PSS®E, PSCAD, Dig SILENT Power Factory and GAMS.

MCTR 304 Hydraulics Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To understand the basic principles of Fluid Mechanics.

- To interpret about Continuity equation, Euler's equation, Bernoulli's theorem.
- To differentiate types of valves.
- To describe the different type's compressors, pumps, actuators and their applications.
- To understand the working of hydraulic motor.
- To know about hydraulic oils and they can design the hydraulic circuits.

Section A

Introduction to Hydraulics, Fluid classifications, Properties of fluid, Shear stresses in a fluid. Pressures & Measurement of Pressure: Absolute, Gauge &Vacuum Pressure, Pascal's law, Hydrostatic law.

Hydrostatic Static Forces on Submerged Bodies: Flat surface & Curved Surface.

Buoyancy and Floatation: Archimedes's Principle, Metacenter.

Fluid Kinematics: Types of Fluid Flow, Flow rate & Continuity Equation.

Fluid Dynamics: Euler's Equation, Bernoulli's theorem.

Application of Bernoulli's theorem: Venturimeter, Orifice Meter, Pitot tube, Notches & Weirs, Flow in Pipes & Losses: Major losses & Minor losses.

Section B

Valves: Directional control valves, Pressure control valves, Proportional control valves, Flow control valves. Hydraulic Cylinders: Single acting, Double Acting. Special Cylinders: Special, Rod less, Telescopic. Fluid power Actuators: Linear & Rotary Actuators. Hydraulic Pumps: Centrifugal Pump, Reciprocating Pump, Rotary Displacement Pump. Compressors: Piston, Screw, Reciprocating, Rotary and Axial. ISO symbols and its Applications. Hydraulic System-Hydraulic Press, Hydraulic lift, Hydraulic Accumulator.

Section C

Hydraulic Oils: Types, Properties and applications. Classification: Mineral based Fire resistant & Biodegradable Oils. Filters, Contaminations and Location of Filter.

Hydraulic Motors: Gear Motors, LSHT Motors, Multi stroke axial piston motors, Multi stroke radial piston motors, Variable Displacement Radial piston motors.

Design of hydraulic circuits: Basic and Industrial hydraulic circuits, Advantages, Application and Design of Electro-hydraulic system, Electro hydraulic Control.

Text Books:-

1. Cimbala John &Cengel A Yungus. *Fluid Mechanics: Fundamentals and Applications* (3rd ed.). McGraw-Hill Education.
2. Majumdar, S R.(2011). *Oil Hydraulic Systems: Principles and Maintenance*. McGraw-Hill Education.
3. Bansal, R K. (2018). *A Textbook of Fluid Mechanics and Hydraulic Machines* (10th ed.). Laxmi Publications.
4. Parr Andrew. (1993). *Hydraulics & Pneumatics*. Jaico Publishing House.

Reference Books:-

1. Frank White. (2015). *Fluid Mechanics*. McGraw-Hill Education.
2. Som,S K, BiswasGautam&Chakraborty,S. (2017). *Introduction to Fluid Mechanics and Fluid Machines* (3rd ed.) McGraw Hill Education.
3. Anthony Esposito. (2008). *Fluid Power with Applications*. Pearson,
4. Jagadeesha T. &ThammaiahGowda. (2013). *Fluid Power: Generation, Transmission and Control*. Wiley.

E-Resources:-

1. https://nptel.ac.in/courses/112105046/
2. https://www.hydraulicspneumatics.com/
3. https://www.coursera.org/lecture/fluid-power/hydraulics-and-pneumatics-SD8dv
4. https://nptel.ac.in/courses/112106175/

MCTR 304L Hydraulics Engineering Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Recognize standard schematic symbols for common fluid power components.
- Design the hydraulic circuit using direction control valve, non return valve, throttle non return valve & controlling by pressure relief valve.
- Understand the basics behind the pressure intensification.
- Understand basic fluid power and troubleshoot electro-hydraulic circuits using schematic diagrams.
- Understand the operation, application, and maintenance of common fluid power components such as pumps, compressors, valves, cylinders, motors, accumulators, pipe, hose, and fittings.

LIST OF EXPERIMENTS

1. To study hydraulics system & pump.
2. To study hydraulic differential cylinder & hydraulic motor.
3. Actuation of double acting cylinder & pressure intensification using 4/2 & 4/3 direction control valve.
4. Actuation of double acting cylinder using pilot operated non return valve.
5. Actuation of double acting cylinder using throttle non return valve.
6. Actuation of double acting cylinder & controlling by pressure relief valve.
7. Design of hydraulic circuit using Hydraulic accumulator.
8. Actuation of double acting cylinder using 4/2 & 4/3 solenoid operated direction control valve.
9. Actuation of double acting cylinder using non return valve with solenoid operated valve.
10. Actuation of double acting cylinder using adjustable throttle valve with 4/2 & 4/3 solenoid operated direction control valve.

11. Actuation of double acting cylinder using flow control valve with 4/2 & 4/3 solenoid operated direction control valve.
12. Actuation of double acting cylinder using pressure reducing valve with 4/2 & 4/3 solenoid operated direction control valve.

ELE 310 Analog Electronics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the operation and properties of Op-amp.
- Explain the design of differential amplifiers, active filters, oscillators, and other linear and non-linear circuits using linear integrated circuits.
- Design and analysis of single stage, multistage amplifiers and high frequency amplifiers.

Section- A

Operational Amplifier and its applications: BJT differential amplifier: DC and AC analysis, Transfer characteristics, Differential and Common mode gain, Ideal Op-amp, inverting and non-inverting amplifier, offset voltage, offset current, bias current, frequency response, slew rate, CMRR, summing amplifier, differential and instrumentation amplifier, design of integrator and differentiator, logarithmic and anti-logarithmic amplifiers, Active filters.

Section- B

Op-amp RC oscillator circuits: Wien bridge, Phase shift; square wave & triangular wave generator, voltage controlled oscillator, Phase locked loops: performance factors, Integrated circuit PLL (565) and its applications, Precision rectifier, comparator, Schmitt trigger and 555 IC Timer, Voltage Regulators: Voltage regulator basics, OP-AMP series voltage regulators, adjustable voltage regulators, ,short circuit protection and fold back current limiting circuits, IC voltage regulators , switching regulators.

Section- C

High frequency amplifiers, Hybrid –pi CE transistor model, Hybrid –pi conductance, Hybrid –pi capacitances, CE short circuit current gain, Current gain with resistive load, Single stage CE transistor amplifier response, Gain bandwidth product.

Multistage Amplifier: Frequency response, Effect of cascading on bandwidth, RC coupled amplifier; Low frequency response of an RC coupled stage, Effect of emitter bypass capacitor.

Recommended Books:

1. Gayakwad, Ramakant A. (2010). *OP-AMP & Linear Integrated Circuits*. New Delhi: Prentice Hall Publication.
2. Bell, David A. (2011) *Operational Amplifiers and Linear ICs*. New Delhi: Oxford University Press.
3. Parikh, Millman&Halkias. (2010) *Integrated Electronics: Analog & Digital Circuits and Systems*. New Delhi: McGraw Hill Education.
4. Sedra, Adel., & Smith, Kenneth. (2009).*Microelectronic Circuits Theory and Applications*. New Delhi: Oxford University Press.

Suggested E-Resources:

1. **Analog Electronic Circuits** by Prof. S. C. Dutta Roy, Indian Institute of Technology Delhi. https://nptel.ac.in/courses/108102095/

ELE 310L Analog Electronics Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Design, construct, and analyze the various analog circuits to compare experimental results in the laboratory with theoretical analysis.
- Observe the amplitude and frequency responses of common amplification circuits
- Construct the desired Electronic design to meet specific requirements.

List of Experiments:

1. To design the Astable Multivibrator using 555
2. To design the Monostable Multivibrator using 555
3. To design summer using 741 IC
4. To design Intergrator using 741 IC
5. To design Schmitt Trigger using 741/555 IC
6. To design Differentiator using 741 IC
7. To design peak detector using 741 IC
8. To design scalar using 741 IC
9. To study active filters: LPF, HPF, BPF.
10. To design Voltage to frequency converter.
11. To study phase locked loop.
12. To study frequency shift keying using PLL 565.

ECE 301 Analog Communication

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain different blocks in communication system and how noise affects communication using different parameters.
- Distinguish between different amplitude modulation schemes with their advantages, disadvantages and applications and analyse generation and detection of FM signal and comparison between amplitude and angle modulation schemes.
- Identify different types of radio receiver circuits.

Section-A

Introduction to signals: Size of signals, Classification of signals, Some useful signal operations, Unit impulse function, Signals and vectors, Signal comparison- correlation, Signal representation by orthogonal signal set, Trigonometric Fourier series, Exponential Fourier series

Analysis and Transmission of Signals: Fourier transform of some useful signals, Some properties of Fourier Transform, Signal Transmission through linear system, Ideal and practical filters, Signal distortion over a communication channel, Signal energy and energy spectral density, Signal power and power spectral density

Section- B

Amplitude Modulation: Baseband and carrier communication, Double sideband modulation, Single sideband modulation, Quadrature amplitude modulation, Vestigial sideband modulation, Carrier acquisition, Superheterodyne receiver

Angle Modulation: Concept of instantaneous frequency, Bandwidth of angle modulated waves, Generation of FM waves, Demodulation of FM, Interference in angle modulated systems, FM receiver

Section-C

Random Signal and Noise: Gaussian Noise, Bandpass noise and its representation, Noise power, SNR ratio, PSD of white noise.

Analog Systems in The Presence of Noise: Baseband system, Double sideband modulation- Suppressed carrier, Single sideband modulation- Suppressed carrier, Amplitude modulation, Angle modulated systems- Phase and Frequency modulation, Optimum preemphasis-deemphasis systems

Systems and Noise Calculations: Electrical Noise, Noise Figure, Equivalent Noise Temperature, Cascade Connection of Two-Port Networks, Free-Space Link Calculations

Recommended Books:

1. Lathi, B.P., Ding, Zhi.,& Gupta, Hari Mohan. (1998). *Modern Digital and Analog Communication Systems*. New Delhi: Oxford University Press
2. Haykin, S. & Moher, M. (2007).*Introduction to Analog and Digital Communication*. New York, United States: John Wiley & Sons.
3. Shilling, D.L., &Taub, H. (2008). *Principles of Communication Systems*. New Delhi: Mc Graw Hill Publication.

Suggested E-Resource:

1. **Analog Communication** by Prof. Goutam Das, G S Sanyal School of Telecommunications, Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses/117105143/

ECE 301L Analog Communication Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Demonstrate Amplitude modulation and demodulation techniques.
- Demonstrate frequency modulation and demodulation technique.
- Analyze generation and detection of FM signal and comparison between amplitude and angle modulation schemes.
- Compare different modulations and demodulations to recognize the advantages and disadvantages of them.
- Identify different radio receiver circuits and role of AGC.

List of Experiments:

1. To Study the Amplitude Modulation and measure modulation Index.
2. To Study the Amplitude Demodulation.
3. To Study the Frequency modulation.
4. To Study the Frequency Demodulation.
5. To Study the Balanced Modulator.
6. To Study the extraction of Single side band from double side bandwidth phase shifter method.
7. To study the extraction Single side band from double side bandwidth Weaver's method.
8. To study the Principle of Ratio Detector.
9. To study the Principle of Foster-Seeley discriminator.

EIE 311 Control Systems

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Formulate mathematical model for physical systems and simplify representation of complex systems using reduction techniques.
- Use standard test signals to identify performance characteristics of first and second-order systems.
- Apply root locus technique for stability analysis.
- Analyse performance characteristics of system using Frequency response methods.

Section A

Open loop and closed loop systems, servomechanism, mathematical model of systems, differential equations and transfer functions, Block diagram algebra, signal flow graphs; +ve and -ve feedback effects of feedback.

Standard test signals, time response of first and second order systems, steady state errors and error constants, Design specifications of second order systems.

Section B

Effects of derivative and integral error compensation, PID controller, Design considerations for higher order systems in brief, performance indices.

Concept of stability, necessary conditions for stability, Routh Hurwitz stability criterion, relative stability criterion, relative stability in terms of Routh Hurwitz criterion; Root-locus technique.

Correlation between time and frequency response specifications; Frequency domain plots, polar plots.

Section C

Bode plot, log magnitude versus phase plots; Gain-margin, Phase-margin, Nyquist stability criterion; Constant-M and constant-N circles; closed loop frequency response from these.

Preliminary considerations of classical design, cascade and feedback compensation, time-domain design using lag, lead and lag lead compensation, frequency domain design using lag.

State Variable model and solution of state equation of LTI systems.

Recommended Books:

1. Nagrath, I. J. (2006). *Control systems engineering*. New Delhi: New Age International.
2. Ogata, K., & Yang, Y. (2002). Modern control engineering (Vol. 4). India: Prentice hall.

Suggested e-resource:

1. **Control System** by Prof. S. D. Agashe, Indian Institute of Technology, Bombay. https://nptel.ac.in/courses/108101037/

EIE 302L Control Systems Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Understand the concept of time response and frequency response of any physical system.
- Mathematical modeling of physical system to find out of transfer system.
- Analyze the stability of system with the help of system response.

List of Experiments:

1. To study and controlling action using PID controller and calculate the first overshoot temperature and plot the graph.
2. To study the DC position controller and find out the tachometer gain.
3. To determine time domain response of a second order systems for step input and obtain performance parameters.
4. To convert transfer function of a system into state space form and vice-versa.

5. To plot root locus diagram of an open loop transfer function and determine range of gain ‘k for stability.
6. To plot a Bode diagram of an open loop transfer function.
7. To draw a Nyquist plot of an open loop transfers function and examine the stability of the system.

ECE 304 Digital Communication

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Analyse and implement the concept of Probability Theory, Random Variables, Error Control Theory and Information Theory in Digital Communication Systems
- Explain the concept of Analog to Digital Conversion, Sampling, Quantization, Pulse Modulation and PCM
- Describe and analyse mathematically the Digital Modulation Techniques-ASK, FSK, PSK

Section A

Introduction to Digital Communications, Sampling Theorem, Pulse amplitude modulation, Pulse code modulation: Uniform and Non- uniform quantization, T1 Carrier System, Differential pulse code modulation, Delta Modulation

Line Coding: PSD of various line codes: polar signaling, on-off signaling, bipolar signaling; Pulse shaping: Nyquist criteria for zero ISI, signaling with controlled ISI, Duobinary pulse, Scrambling, Regenerative repeaters.

Section B

Digital Modulation Techniques: Various techniques of phase shift, BPSK modulation, spectrum, Bandwidth efficiency, geometrical representation of BPSK modulation, spectrum, Bandwidth efficiency, geometrical representation of ASK, FSK& Minimum shift keying

Noise in digital Communication: PCM and Companded PCM SNR, Matched filter, Calculation of error probability for ASK, ASK, FSK.

Section C

Information Theory: The concept of amount of information, Entropy, Information rate, Huffman coding, Channel capacity of a discrete memoriless channel, Shannon's Theorem, Channel capacity, capacity of a Gaussian channel, Bandwidth-S/N trade – off.

Error control coding: Rationale of coding and types of codes, Discrete memory less charnel, some Algebraic concepts -Code efficiency and Hamming bound, linear block codes, Cyclic codes, Convolution codes, maximum likelihood decoding of convolution codes.

Recommended Books:

1. Lathi, B.P., Ding, Zhi.,& Gupta, Hari Mohan. (1998). *Modern Digital and Analog Communication Systems*. New Delhi: Oxford University Press
2. Haykin, S. & Moher, M. (2007) *Introduction to Analog and Digital Communication*. New York, United States: John Wiley & Sons.
3. Shilling, D.L., &Taub, H. (2008). *Principles of Communication systems*. New Delhi: Mc-Graw Hill Publication.

Suggested E-Resources:

1. **Digital Communication** by Prof. Bikash Kumar Dey, Department of Electrical Engineering, Indian Institute of Technology, Bombay. https://nptel.ac.in/courses/117101051/

ECE 304L Digital Communication Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Understand the concept of Sampling and various Pulse Modulation techniques i.e. Pulse Amplitude Modulation and demodulation, Pulse Position Modulation and demodulation and Pulse Width Modulation and demodulation.
- Analyze the behavior of Pulse Code Modulation and demodulation.

- Explain the working of Digital Modulation Techniques ie: Amplitude Shift Keying, Phase Shift Keying and Frequency Shift Keying.

List of Experiments:

1. Familiarization with the lab instruments.
2. To understand the operation of Pulse amplitude modulation and demodulation system
3. To study Pulse width modulation system
4. To study Pulse width demodulation system.
5. To understand the principle of Pulse code demodulation system
6. To study the operation of Pulse position modulation system
7. To study Pulse position demodulation system.
8. Study of amplitude shift keying modulator and demodulator
9. Study of frequency shift keying modulator and demodulator
10. Study of phased shift keying modulator and demodulator

ECE 305 Microwave Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Understand various parameters of waveguide and use of component as per applications
- Design impedance matching network for any transmission line or system
- Analyse and find applications and limitations of microwave Semiconductor devices.
- Find various applications of microwave engineering in specific area

Section- A

Introduction to Microwaves & its application, Microwave Electromagnetic spectrum, Transmission Lines: General equation, input impedance, characteristic impedance, reflection and transmission coefficient, standing

wave ratio, resonant and anti-resonant line impedance matching, Matching techniques: single stub, double stub, quarter wave transformer, baluns, coaxial transmission line, Planar transmission line: Strip line, Microstrip line, Slot line etc.

Section-B

Wave Guides: Wave propagation in rectangular wave guide: solution of TE and TM modes, Power Transmission and Attenuation, Excitation of modes in rectangular waveguide, Circular Waveguide: Basic idea of TE and TM modes, Rectangular and Circular cavity resonators, Q of cavity resonators, S parameters and its conversion with Z and Y parameters, Wave guide coupling, Microwave passive Components: S- parameter representation and analysis of microwave components such as Waveguide Tees, Two-hole directional coupler, attenuators, Phase shifters, Microwave propagation in ferrites: Faraday rotation, Isolators, Circulators.

Section-C

Microwave Tubes: Limitations of Conventional vacuum tubes at microwave, Klystron: Construction and operation of two cavity and multi-cavity klystrons, Applegate Diagram and application of two cavity klystron, Construction and working of Reflex klystron, Magnetron: Types of magnetron,Construction, Operation and Analysis of cavity or travelling wave magnetron, Traveling wave tubes (TWT): Construction, Operation and practical consideration of helical type TWT, Applications of TWT, Microwave Semiconductor Devices: Tunnel diodes, principle of operation and application of tunnel diodes, Transferred Electron devices: Gunn-Effect diodes, Two-valley theory, Mode of operations of Gunn diode, Avalanche Transit-Time devices: IMPATT, TRAPATT.

Recommended Books:

1. Liao, S.Y. (1995). *Microwave devices & Circuits*. New Delhi: Prentice Hall Publication.
2. Rizzi, P.A. (1998). *Microwave Engineering*. New Delhi: Prentice Hall Publication.
3. Collins, R. E. (1992). *Foundation of Microwave Engineering*. New Delhi:McGraw Hill Publication.
4. Pozar, David M. (2008). *Microwave Engineering*. New Delhi: Wiley Publication.

Suggested E- Recourses:

1. **Microwave Theory and Techniques** by Prof. Girish Kumar, Indian Institute of Technology, Bombay. https://nptel.ac.in/courses/108101112/
2. **Basic Building Blocks of Microwave Engineering** by Dr Amitabha Bhattacharya, Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses/117105130/
3. **Transmission Lines and E.M. Waves** by Prof. R. K. Shivgaonkar, Indian Institute of Technology, Bombay. https://nptel.ac.in/courses/117101056/

ECE 305L Microwave Engineering Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Understand the concept and working of microwave bench and different components connected on a bench.
- Analyze the behaviour of various microwave components.
- Explain properties/ characteristic of microwave source, tees and directional coupler.
- Understand the designing process of different microwave components by using HFSS software.

List of Experiments:

A. Experiments to be performed with Microwave Bench

1. Determine the operating frequency of Reflex Klystron and study the Mode characteristic of Reflex Klystron.
2. To verify the Wave-Guide law.
3. Measurement of unknown impedance using Microwave bench.
4. To study the properties of E-plane and H-plane Tee. Determine isolation and coupling coefficient.
5. To study the properties of Magic Tee and also measure isolation and coupling coefficient.

6. To study the directivity and coupling coefficient of Directional coupler.
7. To study the operation of Ferrite Circulator and measure Insertion loss, isolation, cross-coupling and input VSWR.
8. To measure the VSWR of (i) Short Circuit (ii) Open Circuit (iii) Matched load (iv)Unmatched Load.
9. To study the V-I characteristic of Gunn Diode.

B. Experiments to be performed using HFSS Software

1. Designing of Rectangular waveguide using HFSS and study its mode characteristics.
2. Designing of E - Plane Tee using HFSS and calculate S-parameters.
3. Designing of H - Plane Tee using HFSS and calculate S-parameters.
4. Designing of Magic Tee using HFSS and calculate S-parameters.

EIE 310 Process Control

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Understand the basic principles & importance of process control in industrial process plants
- Understand the use of block diagrams & the mathematical basis for the design of control systems;
- Design and tune process (PID) controllers and Use appropriate tools for the modelling of plant dynamics and the design of well-tuned control loops
- Specify safety required in instrumentation, use of control techniques to ensure that well-tuned control is achieved and demonstrate their knowledge in designing the control loops for these processes
- Understand the importance and application of good instrumentation for the efficient design of process control loops for process engineering plants.

Section A

Introduction to Process Control: Objective of Process Control, Benefits, Difficulties and Requirements of Process control Implementation, Process dynamics-Elements of process control, process variables, Process lag and Control lag, Types of Dynamic Processes: Integral process,First order process,Second order process, Dead time, Single/multicapacity, self-Regulating /non self regulating, Linear/non linear,Degree of freedom, Piping and Instrumentation Diagram.

Mathematical Modelling of Processes: Modeling of liquid-level process, gas process, thermal process.Concentration response of a stirred tank, Temperature response of a stirred tank, interacting and Non-interacting two tank level system

Section B

Control Action and Controller tuning: Basic control action-characteristics of on –off, Proportional control, Design of Integral and Derivative Controller, Composite controller models-PD,PI and PID controllers and comparison of these controller actions. Electronic controllers. Response of controllers for different types of test inputs-selection of control mode for different process with control scheme. Optimum controller settings-Tuning of controllers by Process reaction curve method, Continuous cycling method, damped oscillation method.

Section C

Final Control elements: Pneumatic control valve, construction details and types, valve sizing, selection of control valves, inherent and installed characteristics of valve,actuators and positioners.

Complex Control Techniques: Feed forward control, Ratio control, Override control, Cascade control, Split range control, Inferential control, Model predictive control, Adaptive control, Boiler level control, Distillation column control, Furnace control.

Safety in Instrumentation control systems: Area and material classification as per IEC and NEC standard, techniques used to reduce explosion hazards, intrisinic safety and installation of intrinsically safe systems.

Text Books:

1. Bhanot, S. (2008). *Process Control-principles and applications*. Oxford publication.

2. Petruzella, F. D. (2010). *Programmable logic controller* (4th ed.). New York: McGraw Hill.
3. Johnson, C. D. (2002). *Process Control and Instruments Technology*. PHI Education.
4. Patranabis, D. (2008). *Principles of Process Control* (2nd ed.). TMH.
5. Boyer, S. (2003). *SCADA Supervisory Control and Data Acquisition*. ISA Publication.
6. Gruhn,P. &Cheddie, H. (1998). *Safety Shutdown systems*. ISA Publication.

Reference Books:

1. Liptak,B. G. (1995). *Instrument engineers Handbook-Process Control* (3rd ed.). Chilton book company.
2. Liptak,B. G. (1995). *Instrument engineers Handbook-Process Measurement and Analysis* (3rd ed.). Elsevier India.
3. Chidambaram, M. (2002). *Computer Control of Processes*. Narosa Publication.
4. Padmanabhan, T. R. (2000). *Industrial Instrumentation Principle and Design*. Springer Verlag.

e-Resources:

1. https://nptel.ac.in/courses/103103037/
2. https://ocw.mit.edu/courses/chemical-engineering/10-450-process-dynamics-operations-and-control-spring-2006/
3. https://www.coursera.org/courses?query=process%20control
4. https://swayam.gov.in/courses/1395-industrial-automation-and-control

EIE 310L Process Control Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Programming of Programmable Logic Controllers and its applications in process industry.
- Design and deploy Programmable Logic Controller programs using timers and counters.
- Design applications based on logic and arithmetic operations using Programmable Logic Controllers.
- Implement the various real life applications using Programmable Logic Controllers.

LIST OF EXPERIMENTS

Programmable Logic Controller: Bosch Rexroth (Indra-Control L-25) &
Mode of Programming: Ladder Logic

1. Introduction to Bosch Rexroth (Indra-Control L-25) and its configuration procedure.
2. Draw a ladder program for tank filling process and simulate on universal simulator kit.
3. Implementation of pump control using universal simulator kit.
4. Application of latches for implementing star-delta start-up.
5. Draw a ladder program for pole changing switch and simulate on universal simulator kit.
6. Controlling of furnace door on universal simulator kit.
7. Write a ladder logic program for control of traffic light.
8. Automatic tablet filling on universal simulator kit.
9. Draw a ladder logic diagram for selective belt switch in process.
10. Application of level control in industrial process.
11. Application of mixing operation of two fluids in industrial process.

ECE 411 Communication Engineering

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes

The Students will be able to:

- Use different modulation and demodulation techniques used in analog communication
- Identify and solve basic communication problems
- Analyze transmitter and receiver circuits
- Compare and contrast design issues, advantages, disadvantages and limitations of analog communication systems
- Understand various spreading techniques and determine bit error performance of various digital communication systems.
- Differentiate between different pulse modulation and demodulation techniques and signal multiplexing for various applications.

Section A

Amplitude Modulation: Amplitude modulation and detection, Generation and detection of DSB-SC, SSB and vestigial side band modulation, carrier acquisition, AM transmitters and receivers, superhetrodyne receiver, IF amplifiers, AGC circuits, Frequency Division multiplexing

Angle Modulation: Basic definitions, Narrow band and wideband frequency modulation, transmission bandwidth of FM Signals, Generation and detection of frequency modulation.

Section B

Sampling process. Analog Pulse Modulation Systems-Pulse Amplitude Modulation, Quantization process, quantization noise, Pulse code Modulation, Differential Pulse code Modulation, Delta Modulation, Types of digital modulation, waveforms for amplitude, frequency and phase shift keying, methods of generation of coherent and non-coherent ASK, FSK and PSK, comparison of above digital techniques.

Section C

Time Division Multiplexing: Fundamentals, Electronic Commulator, Bit/byte interleaving, Tl carrier system, synchronization and signaling of Tl, TDM and PCM hierarchy, synchronization techniques

Introduction to Information Theory: Measure of information, Entropy & Information rate, channel capacity, Hartley Shannon law, Huffman coding, Shannon Fano coding.

Text Books:

1. Haykin, S. (2006). *Communication Systems* (4th ed.). John Wiley &Sons.
2. Kennedy, G. & Davis, B. (2017). *Electronic Communication systems*(4th Ed.). Tata McGraw Hill.
3. Haykin, S. (2013). *Digital Communications.*John Wiley & Sons.

e-Resources:

1. https://nptel.ac.in/courses/117102059/
2. https://onlinecourses.nptel.ac.in/noc18_ee03/preview
3. https://swayamprabha.gov.in/index.php/program/current/14
4. https://nptel.ac.in/courses/108104098/
5. https://nptel.ac.in/syllabus/117102059/
6. https://nptel.ac.in/courses/117106090/3

MCTR 419 Mechatronics Systems

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Develop skills to monitor and control real world industrial systems
- Implement projects for industrial and home automations
- Analyze and create own innovative filters and signal conditioning applications
- Perform computer based controlling of industries using PLC, SCADA and HMI

Section A

Fundamentals of Mechatronics and its Evolution, Hardware elements of Mechatronics systems.

Introduction of Transducer: LVDT, Optical Encoder, Inductive Proximity and Capacitive Proximity Sensor, Reed switch, Hall Effect, Photoelectric (Through Beam, Retro reflective, Diffused Type), Thermocouples, Tactile Sensor, Float type level switch, Smart Sensor.

Signal conditioning: Amplifiers, Passive Filters.

PC based Control: Data Acquisition System: Analog and Digital, Role of SCADA and HMI System.

Section B

Mechanical actuation system- Kinematic chains, cams, gear-trains, Ratchet & Pawl, dampers, Bearings, Belt Drive, Introduction to MEMS.

Electrical actuation system: Solenoids and Stepper Motors.

Actuators: Fluid Power, Piezoelectric Actuator, Magnetostrictive Actuator.

Electrical Drives: Conventional and Modern electrical drives, Classifications and Applications

Section C

Case Studies of Mechatronics Systems: Additive 3-D Printer, Process Automation, Industry 3.0, Industry 4.0.

Text Books: -

1. Isermann, R. (2006). *Mechatronics Systems: fundamentals*. Springer.
2. Bolton, W. (2010). *Mechatronics*(4th ed.). Pearson Education.
3. Sawhney, A. K. (2015). *A Course in Electrical and Electronic Measurements and Instrumentation*. Dhanpat Rai Publication.
4. Nakra, B.C. &Choudhary, K.K. (2016). *Instrumentation, Measurement and Analysis* (4th ed.). Tata McGraw Hill.

E-Resources:

1. https://www.edx.org/course/sensors-and-devices-in-the-iot
2. https://nptel.ac.in/courses/108108123/
3. https://nptel.ac.in/courses/112103174/
4. https://ocw.mit.edu/courses/mechanical-engineering/2-737-mechatronics-fall-2014/

5. https://nptel.ac.in/courses/112104265/
6. https://onlinecourses.nptel.ac.in/noc17_me31/preview

MCTR 419L Mechatronics Systems Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes

The Students will be able to:

- Simulate the basic electric, hydraulic and pneumatic system using simulation software.
- Develop an understanding of plc ladder diagram related to industrial automation systems and measure its performance.
- Design Mechatronics system according to an Industrial Applications.
- Combine the real time control systems with peripheral devices through programmable interface techniques.

LIST OF EXPERIMENTS

1. Study of Modular Mechatronics System (MMS) and its components.
2. To design and assemble the components of distribution or feeding station.
3. To design and assemble the components of testing station.
4. To design and assemble the components of sorting station.
5. To study different modes of operation of a six axis industrial robot.
6. To study about Selective Compliance Articulated Robotic Arm (SCARA) station.
7. To study about IOT and RFID application in Mechatronics System.
8. To study and control different parameters in process automation.

ELE 410 Digital Signal Processing

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	3	1	0	4

Learning Outcomes

The Students will be able to:

- Demonstrate the analytical representation of discrete time signals.
- Apply techniques in time and frequency domain to the analysis and design of discrete time systems.
- Analyze discrete time systems in both time and frequency domain.
- Design and analysis of the frequency response of discrete-time signals and systems.
- Design, Analyze and Implement Digital IIR and FIR filters.

Section A

Introduction of Signals, Systems and Signal Processing, Classification of Signals and Systems, Advantages of digital over analog Signal processing, Signal Models - Continuous Time versus Discrete time signals, Periodic and aperiodic Signals, Phasor Signals and Spectra, Energy and Power Signals, System Modeling Concepts, The superposition integral for Fixed and Linear Systems, Impulse Response of a Fixed and Linear System - Fourier Series - Trigonometric Series- Exponential Fourier Series- Symmetry Properties of the Fourier Coefficients. Fourier Integral, Energy Spectral Density, Fourier Transforms in the Limit, Fourier Transform Theorems and Pairs, System Analysis with Fourier Transform, Lap lace Transform Theorems, Network Analysis using the Lap lace Transform.

Section B

Discrete Time Signals and Systems- Review of Sampled Data Systems, Time Domain Representations of Discrete Time Signals, Frequency Domain Representation of Discrete Time Signals, Discrete Time Signals obtained by sampling, Discrete Fourier Transform. Z-Transform - Definition and Examples, Inverse Z-Transform, Properties of the Z-Transform, Introduction to Realization of Digital Systems - Block Diagrams and Signal Flow Graphs. Introduction to Realization of an IIR and FIR systems, Discrete Fourier Transforms (DFT) and Fast Fourier Transform (FFT).

Section C

Design of Digital Filters: Introduction to Filters, A comparison of IIR and FIR Digital Filters. Design of IIR Digital Filters –Impulse Invariant Transformation, Bilinear Transformation, Design of Digital Butter worth and Chebyshev Filters. Design of FIR Digital Filters - Windowing and Rectangular Window, Filter Designs using Windows, Frequency Sampling Technique. DSP tools and DSP techniques in various applications.

Text Books:

1. Johnson J. R. (1998).*Introduction to Digital Signal Processing*.India: Prentice-Hall
2. Oppenheim , A. V., Willsky, A. S. &Nawab, H.S. (1996). Signal & Systems.India: Prentice-Hall.
3. Proakis J. G. &Manolakis, D. G. (2007). Digital Signal Processing: Principles, Algorithms,

   and Applications (4th ed.). India: Prentice-Hall

e-Resources:

1. https://swayam.gov.in/course/3674-discrete-time-signal-processing
2. https://nptel.ac.in/courses/117102060/1
3. https://swayam.gov.in/courses/5452-jan-2019-principles-of-signals-and-systems
4. https://ocw.mit.edu/resources/res-6-008-digital-signal-processing-spring-2011/
5. https://nptel.ac.in/courses/117104070/
6. http://www.nptelvideos.in/2012/11/digital-signal-processing.html
7. http://jpkc.gnnu.cn/jpkc/Signal/ziliaoxiazai/Oppenheim%20%20Signals%20And%20Systems%20(Complete).pdf

ELE 304L Digital Signal Processing Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- Able to generate elementary signals/ waveforms and perform arithmetic operations on signals.
- Able to plot frequency response of a given system and verify the properties of LTI system
- Able to carry out simulation of DSP systems.
- Able to demonstrate the applications of FFT to DSP.

LIST OF EXPERIMENTS

1. Write a program in MATLAB to generate the following functions: Unit Impulse, Unit Step, Unit Ramp, Sinusoidal, Exponential, Random signal.
2. Write a program in MATLAB to study the basic operations on the discrete time signals: Amplitude Scaling, Time Shifting, Time Scaling, Folding, addition and multiplication of two signals.
3. Write a program in MATLAB to check for linearity, causality and stability of discrete time system.
4. Write a program in MATLAB to perform Linear Convolution.
5. Write a program in MATLAB to perform Circular Convolution.
6. Write a program in MATLAB to perform the Discrete Fourier transform for the given sequences.
7. Write a program in MATLAB to perform Inverse Discrete Fourier transform for the given sequences.
8. Write a program in MATLAB to design analog Butterworth filter for the given specifications.
9. Write a program in MATLAB to design analog Chebyshev filter for the given specifications.
10. Write a program in MATLAB to find frequency domain response (magnitude and phase response) for the given IIR and FIR systems.

EEE 404 Switchgear and Protection

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes

The Students will be able to:

- Design the feasible protection systems needed for each main part of a power system
- Understand different applications of the relays, circuit breakers, grounding for different elements of power system
- Understand characteristics of different type of relays
- Design the ratings for fuses according to the requirement
- Elucidate various protection schemes of various power system components like alternators, transformers and bus-bars
- Understand various methods of over voltage protection in power systems

Section A

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

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

Relay Application and Characteristics: Amplitude and phase comparators, duality, over current relays, directional relays, distance relays, differential relay.

Section B

Static Relays*:* Comparison with electromagnetic relay, classification and their description, over current relays, directional relay, distance relays, differential relay.

Protection Of Transmission Line*:* Over current protection, distance protection, pilot wire protection, carrier current protection, protection of bus, auto reclosing.

Section C

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

Testing Of Circuit Breaker*:* Classification, testing station and equipments, testing procedure, direct and indirect testing, Operating modes, selection of circuit breakers, constructional features and operation of Bulk Oil, Minimum Oil, Air Blast, SF6, Vacuum and DC circuit breakers.

Text Books:

1. Ram, B. &Vishwakarma, D. N. (2017). *Power System Protection and Switchgear* (2nd ed.).Tata Mc. Graw Hill.
2. Ravindranath, B. &Chander, M. (2018). *Power system Protection and Switchgear.* (2nd ed.). New Age International Publishers
3. Rao, S. S. (2008). *Switchgear and Protection.* Khanna Publishers.

Reference Books:

1. Paithankar, Y. G. &Bhide, S. R. (2013) *Fundamentals of Power System Protection*. (2nd ed.). India, Prentice Hall.
2. Rao, T. S. M. (2017). *Power System Protection: Static Relays with Microprocessor Applications.* (2nd ed.). Tata Macgraw Hill".
3. Warringtaon, A.R. V. C. (2014). *Protective Relays- Their Theory and Practice, Vol. I & II.* Springer.

e-Resources:

1. https://nptel.ac.in/downloads/108101039/
2. https://nptel.ac.in/courses/108101039/3
3. http://www.vssut.ac.in/lecture_notes/lecture1425873259.pdf
4. https://electrical-engineering-portal.com/transformer-feeder-protection

EEE 411L Switchgear and Protection Lab

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	2	1

Learning Outcomes

The Students will be able to:

- Assemble & de-assemble air circuit breaker
- Understand interconnection of contractor & MCCB
- Apply accurate protection scheme through ETU
- Implement soft starting for 3-phase induction motor
- Apply star-delta starting for 3-phase induction motor

LIST OF EXPERIMENTS

1. Study of 3WL air circuit breaker.
2. Study of 3WT air circuit breaker.
3. Study of molded case circuit breaker (MCCB).
4. Study of electronic trip unit (ETU).
5. Soft starting of 3-phase induction motor.
6. Study of Type-II coordination for contactors.
7. Study and operation of timer & relay.
8. Study and operation of star-delta starter.

MCTR 408 Computer Integrated Manufacturing System

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes

The Students will be able to:

- To apply the concepts to manufacturing industries to automate its various functions.
- To perform various operations on CNC machines in a manufacturing industry.
- To increase the productivity of a manufacturing industry.

- To perform all of the functions of a manufacturing industry with high accuracy and quality.
- To design automated material handling and storage system in a manufacturing industry.
- To apply the concepts of computer aided production management in a manufacturing industry.

Section A

Introduction to CIM: Definition, needs and benefits of CIM, its hardware and software, nature and types of manufacturing systems.

Product development through CIM: Product development Cycle, Rapid prototyping, Techniques to reduce the lead time and manufacturability.

Numerical Control (NC) and Computer Numerical Control (CNC): Basic components of an NC system, coordinate system and motions control systems. Applications, advantages and disadvantages.

NC Part programming: Manual and computer assisted part programming, Part programming with APT. Features of CNC, machine control unit, Direct Numerical Control and Distributed Numerical Control. Adaptive control of machining system.

Section B

Computer Aided Process Planning: Process planning, structure of process planning software, Information required for process planning.

Group Technology: Introduction, part families, part classification and coding, coding system and machining cells. Optiz classification system, process selection, Decision table and Decision trees, Method for process planning, Generative, and Variant process planning, Retrieval process planning system, Implementation considerations.

Networking Fundamentals for CIM: Ethernet, LAN, Managing remote systems in a network.

Material Handling and Storage: Automatic Guided Vehicle (AGV), Automatic Storage & Retrieval System (ASRS). Robots in CIM.

Section C

Computer Aided Production Management Systems: Computer process monitoring and shop floor control, phases, factory data collection.

System-automatic identification methods: Bar code & RFID technology, automated data collection system, computer process control.

Planning of Resources for Manufacturing through Information Systems: Role of MRP II in CIM systems, Common terminologies in MRP-II environment, Enterprise resource planning, supply chain management.

Computer Aided Quality Control: Contact inspection methods, Non-contact inspection methods, Coordinate Measuring Machine, Post process metrology, optical and non-optical computer aided testing, Computer aided inspection by robot.

Text Book:-

1. Mikell, P. Groover. Automation*, Production Systems, and Computer Integrated Manufacturing* (3rd ed.). Pearson/Prentice Hall.
2. Radhakrishnan, P., Subramanyam, S., & Raju, V. (2013). *CAD/CAM/CIM* (3rd ed.). New Age Publisher.
3. Rao, P.N. *CAD/CAM: Principles and Applications*. McGraw Hill
4. Rao, Tiwari & Kundra. *Computer aided Manufacturing*. Tata McGraw Hill.
5. Mikell P. Groover & Emory W. Zimmers. *CAD/CAM: Computer-Aided Design and Manufacturing*. Prentice-Hall of India Pvt. Ltd.

Reference Books:-

1. James A. Rehg & Henry W. Kraebber. *Computer-Integrated Manufacturing* (3rd ed.). Pearson/Prentice Hall.
2. Chang, Wysk& Wang. *Computer Aided Manufacturing*. Pearson Education.
3. Koren, Y. *Computer Control of Manufacturing Systems*. McGraw Hill.
4. Quesada & Jeyepoovan. *Computer Numerical Control: Machining and Turning Centres*. Pearson Education.

e-Resources:-

1. https://nptel.ac.in/courses/112102101/
2. https://nptel.ac.in/courses/112102103/16
3. https://nptel.ac.in/courses/112105211/
4. https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2-008x-0
5. https://nptel.ac.in/courses/112104265/

MCTR 408L Computer Integrated Manufacturing System Lab

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	2	1

Learning Outcomes

The Students will be able to:

- To control the robot operations in real environment manually as well as using simulation software.
- To manufacture the complex objects by computer assisted part programming.
- To perform various operations on CNC machines in a manufacturing industry.
- To apply the basics of Gantry system to pick and place robots.
- To design Vision Inspection System for several parametric inspections of the specimens.
- To design various automatic material handling systems.

LIST OF EXPERIMENTS

1. Introduction to Aristo robot manual offline commands.
2. Aristo Sim software Simulation for robot operations.
3. Study of CIM offline and online programming.
4. Operation and Programming on CNC Milling.
5. Operation and Programming on CNC Turning.
6. Introduction and operation of Gantry Systems and calibration of loading and unloading of objects.
7. Introduction and operation of Vision Inspection System for several parametric inspections of the specimens.
8. Introduction and operating of ASRS and AGV.

ECE 409 Antenna Analysis

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Recall electromagnetic plane waves. Apply principles of electromagnetic to explain antenna radiation. Explain various antenna parameters.
- Explain antenna as a point source. Design antenna patterns for different cases.
- Explain dipole antennas. Establish mathematical equations for various parameters of thin linear antenna.
- Explain loop, slot, patch and horn antennas. Derive expressions for the parameters of loop and slot antennas.

Section-A

Introduction to antenna, Radiation Mechanism, Current Distribution on a Thin Wire Antenna

Fundamental parameters of antenna: Radiation pattern, Radiation power density, Radiation intensity, Beamwidth, Directivity, Antenna efficiency, Gain, Beam efficiency, Bandwidth, Polarization, Input impedance, Antenna radiation efficiency, Antenna vector effective length, Maximum directivity and Maximum effective area, Friis transmission equation and radar range equation

Section-B

Radiation Integrals and Auxiliary Potential Functions: The Vector Potential A for an Electric Current Source J, The Vector Potential F for a Magnetic Current Source M, Electric and Magnetic Fields for Electric (J) and Magnetic (M)Current Sources, Solution of the Inhomogeneous Vector Potential Wave Equation, Far-field radiation, Duality theorem, Reciprocity and Reaction theorem, Image Theory

Linear wire antennas: Infinitesimal dipole, Small dipole, Region separation, Finite length dipole, Half-wave dipole

Loop Antennas: Small circular loop, Square loop

Section-C

Introduction to Arrays, two-element array, N-element linear array: uniform amplitude and spacing, directivity, N-element linear array: uniform spacing, non-uniform amplitude

Traveling wave antennas: Long wire antenna, V-antenna, rhombic antenna

Broadband antennas: Helical antenna, Folded dipole, Yagi-uda array of linear elements

Log-periodic antenna, Introduction to Horn antenna: E-plane sectoral horn, H-plane sectoral horn, Pyramidal horn

Recommended Books:

1. Balanis, C. A. (2005). *Antenna Theory Analysis and Design.* New Delhi: John Wiley & Sons.
2. Eliott, Robert S. (2003). *Antenna Theory and Design*. New Delhi: Wiley-IEEE Press.
3. Kraus, J. D., & Marhefka, R. H. (2001). *Antennas for All Applications,* Singapore: McGraw-Hill Publication.
4. Harrington, R. F. (2001). *Time-Harmonic Electromagnetic Fields*. New Delhi: Wiley-IEEE Press.

Suggested E- resources:

1. **Advanced Antenna Theory** by Dr Amalendu Patnaik, Indian Institute of Technology, Roorkee. https://nptel.ac.in/courses/117107035/
2. **Analysis and Design Principles of Microwave Antennas** by Prof. Amitabha Bhattacharya, Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses/108105114/
3. **Antennas** by Prof. Girish Kumar, Indian Institute of Technology, Bombay. https://nptel.ac.in/courses/108101092/

ECE 409L Antenna Analysis Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Use HFSS tool to design and analysis of antennas.
- Design various type of antennas

- Measure and analyse radiation pattern of antennas.

List of Experiments:

1. To design dipole antenna in HFSS
2. Design monopole antenna in HFSS
3. Design horn antenna in HFSS
4. To measure radiation pattern of Horn Antenna
5. To measure radiation pattern of log periodic Antenna
6. To measure radiation pattern of micro strip patch Antenna
7. To measure radiation pattern of YAGI-UDA Antenna.

ECE 402 Fiber Optics and Communication

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the light propagation through optical fibers.
- Explain the various light sources and optical detectors.
- Design fiber optic transmitter and receiver system.

Section A

Fiber optics: Introduction, optical fibers -geometrical Optics description, wave propagation, fiber modes, step index, graded index single and multimode fibers, dispersion, limitation on bit rate, fiber bandwidth, fiber loss, fiber manufacturing: design issue, fabrication methods, cables and connectors, fiber splicing and fiber couplers.

Section B

Optical Sources and detectors: Light-Emitting diodes: LED characteristics, modulation response, LED structures. Semiconductor Lasers: structures, Laser characteristics, single longitude mode operation, DFB and VCSEL laser, Receivers: photo detector design: P-N, PIN, Schottky barrier and Avalanche photodiode, Phototransistor, receiver noise: noise mechanisms in PIN and APD receivers, Receiver structures.

Section C

Optical Fiber Systems: optical transmitter circuit: source limitations, LED and Laser drive circuits, Optical receiver circuit, system design considerations, Digital systems, Digital optical receiver, BER, Optical power budgeting, rise time budget, line coding, analog systems: Direct intensity modulation, subcarrier intensity modulation, coherent systems, computer, sensor and military applications.

Recommended Books:

1. Agarwal, Govind. P. (2007). *Fiber-Optic Communication Systems***.** New Delhi: Wiley India.
2. Senior, John.M. (2009). *Optical Fiber Communication Principles & Practice***.** New Delhi: PHI Publication.
3. Bhattacharya, Pallab. (2002). *Semiconductor Optoelectronics Devices***.** New Delhi: PHI Publication.
4. Keiser, Gerd. (1991). *Optical Fiber Communication***.** New Delhi: McGraw Hill Publication.

ECE 402L Fiber Optics and Communication Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Understand the characteristics of an optical fiber and LED.
- Understand and measure the basic properties of propagation of light in dielectric Optical fibre including losses, attenuation and coupling.
- Explain the working of optical power meter and various sensors.

List of experiments:

1. To study Analog Link.
2. To study Digital link.
3. To measure Numerical aperture.
4. To study Propagation Loss.
5. To study Bending Loss.
6. To study EYE Pattern.

7. To calculate BER.
8. To study the characteristics of optical source.
9. To study the characteristics of Optical detector.

VLSI 401 VLSI Design

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the basic theory of crystal growth, wafer fabrication and IC fabrication technology.
- Explain the different VLSI design styles, overview of ICs and fabrication steps of MOS, CMOS and BJT.
- Design and analyse the output characteristics of different MOS inverters
- Design combinational and sequential circuit.

Section A

Recapitulation of basics, semiconductor devices, orientation effect, impurities, defects, Fabrication: Crystal growth & wafer preparation, Epitaxial growth, oxidation, photo-lithography, etching technology (wet & dry), Diffusion Fick's law, chemical vapor deposition, CVD reactors, ion implantation, metallization & patterning, photo resistive material, packaging.

Section B

Overview of VLSI methodologies, VLSI design flow, type of ICs (monolithic, thick film, thin film, hybrid), Fabrication steps involve in, different type of resisters, capacitor, diode, transistor (Darlington etc), JFET, MOSFET, isolation technique used in fabrication, fabrication of typical circuits.

Section C

Digital CMOs circuit, MOS devices, V-I characteristics, Design & detailed analysis of MOS inverters (resistive load, enhancement load, depletion

load, CMOS), delay & power analysis, Design layout of simple CMOS gates.

Circuit implementation of combinational circuit, circuit implementation of sequential circuits - FFs, SRAM, DRAM.

Recommended Books:

1. *Sze, S.M.(2017). VLSI Technology.* New Delhi*: TMH Publications.*
2. Kang, S.M., &Leblebici, Y. (2002). *CMOS digital Integrated Circuits Analysis & Design*. New Delhi: McGraw Hill Publications.
3. Botkar, K. R. (2004). *Integrated Circuits*. New Delhi: Khanna Publishers.
4. Gandhi, S.K. (1994). *VLSI Fabrication Principle Silicon and Gallium Arsenide*. New Delhi: Willey Publications.
5. Plummer, J., Deal, M., & Griffin, P. (2000). *Silicon VLSI Technology: Fundamentals, Practice and Modeling*. New Delhi: Pearson Publications.
6. Sarrafazadeh, M.,& Wong, C.K. (1996). *An introduction to VLSI Physical Design*. New Delhi: McGraw Hill Publication.
7. Ken, Martin. (1999). *Digital Integrated Circuits Design.* New York, United State: Oxford University Press.
8. Neil, H.E., Weste, &Eshraghian, Kamran (1994). *Principle of CMOS VLSI Design*. Boston, New York: Addison Wesley Publication.

Suggested E-Resources:

1. **VLSI Circuits** by Prof. S. Srinivasan, Department of Electrical Engineering, IIT-Madras. https://nptel.ac.in/courses/117106092/1
2. **VLSI Technology** by Dr. Nandita Das Gupta, Department of Electrical Engineering, IIT-Madras. https://nptel.ac.in/courses/117101058/

VLSI 402L VLSI Design Lab

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	2	1

Learning Outcomes: After completion of this laboratory course, students will be able to:

- Use VHDL for design of digital circuits
- Model complex digital systems at several level of abstractions; behavioral and structural, synthesis and rapid system prototyping.
- Develop and simulate register-level models of hierarchical digital systems

List of experiments:

1. Write a program for the implementation of half adder and Full adder.
2. Write a program for implementing half subtractor and full subtractor.
3. Write a program for implementing MUX 4x1 and DEMUX (1X4)
4. Write a program for implementing Encoder and Decoder.
5. Write a program to implement gray code to binary code converter and vice versa.
6. Write a program to implement COMPARATOR.
7. Write a program for the implementation of S-R Flip flop and D Flip flop.
8. Write a program for the implement up-counter and down-counter.
9. Write a program to design JK Flip-flop and write design summary
10. Write a program to design T Flip-flop and write design summary

ECE 303 Communication Networks

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes: After successful completion of the course, student will be able to:

- Recognize and describe about the working of Computer Networks.
- Illustrate reference models with layers, protocols and interfaces.

- Combine and distinguish functionalities of different Layers.
- Model the LAN and WAN configuration using different media

Section A

Introduction to communication systems and data communications. Introduction of network, requirement of Internet. Data Networking, Network history, Local area network topologies, WAN, MAN,VPN, (Virtual Private Network). Bandwidth, Bandwidth data rate. Multiplexing-TDM, FDM, CDMA, data encoding. Network model-layer structure of network model. OSI Model, OSI layers. TCP/IP Model layers. Arpanet, Peer to Peer communication. Communication Media and cable-structure-through wire-copper cable-STP, UTP, co-axial cable, optical fiber. Wireless media-wireless LAN, organization and standards. Wireless devices and topologies. Wireless communication, wireless security.

Section B

Network layer devices-Modem, NIC, hub, bridge, switch, router, firewall, gateway. Switching Networks-circuit switching, Packet Switching. Networks-Circuit Switching, Packet Switching. Networks addressing schemes-MAC Address, Subneting, Superneting. Routing Concept, Routing protocol (RIP), Routed protocols. Introduction to IPV6 Principles of Internetworking. Ethernet (CSMA/CD) Token Ring and FDDI, Fast Ethernet.

Section C

Layer protocol Structure. Data link control – Flow Control, Error Detection, Error Control. HDLC. Network layer-ARP, RARP, ICMP. Effect of Congestion and Congestion Control in Network-(Back pressure, choke packet, Implicit Congestion Signaling, Explicit Congestion Signaling. Traffic Management- Transport layer Protocols-connection oriented and connectionless services, TCP, TCP Congestion Control and Flow Control. UDP. Application Layer Protocols – HTTP, FTP, SMTP, SNMP, Telnet. Introduction to ISDN. Narrow Band and Broad Band. Introduction to WAN Technologies. ATM and Frame relay.

Recommended Books:

1. Jordan, E.C.(1986). *Electromagnetic Wave & Radiating System*. New Delhi: PHI Publication.
2. Tanenbaum, A.S. (1997). *Computer Networks*. New Delhi: Pearson Publication.
3. Stailling, W. (1997). *Data & Computer Communication*. New Delhi: PHI Publication.
4. Martin, J. (1998). *Computer Networks and Distributed Processing Software, Techniques, Architecture*. New Delhi: PHI Publication.

Suggested E-Resources:

1. **Computer Networks and Internet Protocol** by Prof. Soumya Kanti Ghosh Department of Computer Science and Engineering Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses /106105183/
2. **Computer Networks** by Prof. Sujoy Ghosh, Department of Computer Science and Technology, IIT KG. https://nptel.ac.in/courses/ 106105081/
3. **Computer Networks** by Prof. Hema A Murthy, IIT Madras. https://nptel.ac.in/courses/106106091/
4. **Data Communication** by Prof. Ajit Pal, IIT KG. https://freevideolectures.com/course/2278/data-communication

Discipline Electives

EIE 408 Artificial Neural Network and Fuzzy logic

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes

The Students will be able to:

- To comprehend the concepts of feed forward neural networks
- To analyze the various feedback networks.
- To understand the concept of fuzziness involved in various systems and fuzzy set theory.
- To comprehend the fuzzy logic control and adaptive fuzzy logic and to design the fuzzy control using genetic algorithm.
- To analyze the application of fuzzy logic control to real time systems.

Section A

Introduction: Evolution, biological neurons and synapses, characteristics of artificial neuralnetwork (ANN), types of activation function;Neuron model McCulloch-Pitts model, Hebbian hypothesis; learning and limitations of single-layered neural networks.

Section B

Perceptron: Perceptron representation, concept of linear separability, limitation of perceptron, Perceptron learning algorithms.

Multi-Layer Feed-forward Neural Networks: Multi-layer perceptrons, supervised learning, Approximation and interpolation of functions. Back-propagation learning law.

Adaptive Resonance Theory: Network configuration, characteristics, learning.

Section C

Fuzzy Logic: Introduction -uncertainty and information, fuzzy sets and membership.Classical set and fuzzy sets: operation and properties, classical relations and fuzzy relations:operation and properties, membership value assignments:max–min method.Features of membership function, standard forms and boundaries, fuzzification,defuzzification methods: max

membership principle,centroid method, weighted average method, mean-max membership.

Development of membership functions: Intuition, inference, neural networks.

Fuzzy rule based systems: Natural language, linguistic hedges, rule based system, graphical techniques of inference.

Fuzzy control system: Simple fuzzy logic controller, basic fuzzy tipping problem.

Text Books:

1. Haykin, S.S. (2008). *Neural Networks*. Pearson Publication.
2. Ross,T. J. (2016). *Fuzzy Logic with Engineering Applications*(4th ed.). Wiley.

Reference Books:

1. Fausett,L. V. (1993). *Fundamental of Neural Network Architecture and Application*. Pearson Publication.
2. Zurada, J. M. (2004). *Introduction to Artificial Neural Systems*. JaicoPublishing House.
3. Kumar,S. (2007). *Neural Networks: A Classroom Approach*. TMH.
4. Sivanandam,S., Sumathi,S. &Deepa,S. N. (2006). *Introduction to neural networks using MATLAB 6.0.* Tata McGraw Hill Education India.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc19_ge07/preview
2. https://nptel.ac.in/courses/117105084/
3. https://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-641j-introduction-to-neural-networks-spring-2005/
4. https://nptel.ac.in/courses/108104049/16

EEE 402 Energy Efficiency and Conservation

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes

The Students will be able to:

- To understand the basic principles of Energy conservation
- To interpret about Concept and Scope of Demand Side Management
- To describe the Distribution System.
- To know about Efficiency in Motors and Lighting system.

Section A

Energy conservation:-Principles of Energy Conservation, Energy conservation Planning Energy conservation in small scale industries, Large scale industries and in electrical generation, transmission and distribution, Energy conservation Legislation Energy Audit:-Aim of energy Audit, Strategy of Energy Audit, Energy management Team Considerations in energy conservation Ac. Buildings, Economic analysis. Programme, Instruments for energy audit, Energy audit of System

Section B

Demand Side Management:-Concept and Scope of Demand Side Management, Evolution of Demand Side Management, DSM Strategy Planning. Implementation and its application. Customer Acceptance & its implementation issues. National and International Experiences with DSM Voltage and Reactive power in Distribution System:- Voltage and reactive power calculations and control: Voltage classes and nomenclature, voltage drop calculations, Voltage control, VAR requirements and power factor, Capacitors unit and bank rating lion of capacitors and switching, Controls for switched capacitors and fields testing.

Section C

Efficiency in Motors and Lighting system:- Load scheduling/shifting, Motor drives- motor efficiency testing, energy efficient motors, and motor speed control. Lighting- lighting levels, efficient options, fixtures, day lighting, timers, Energy efficient windows. UPS selection, Installation operation and maintenance. Indian Electricity Act 1956, Distribution Code and Bill

Text Books

1. Tripathy, S. C. (1980). *Electric Energy Utilization and conservation.* Tata McGraw Hill.
2. Gyftopoulos, E. P (1982). *Industrial Energy Conservation Manuals*. Atlanta:Fairmont Press.
3. Dryden, I. G. C. (2013). *The Efficient Use of Energy* (2nd ed.). Butterworth-Heinemann.

Reference Books

1. Tumer, W. C. (1982).*Energy Management Handbook*. New York: Wiley.
2. Witte,L. C., Schmidt,P. S. &Brown, D.R. (1988). *Industrial Energy Management and Utilization*. Washington: Hemisphere Publication.
3. Longland, T. (1984). *Power Capacitor Handbook*. Butterworth & Co (Publishers) Ltd
4. Lazar, I. (1980). *Electrical Systems Analysis and Design for Industrial Plants.* McGraw-Hill Book Company.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc17_mm17/preview
2. https://nptel.ac.in/courses/105102175/
3. https://beeindia.gov.in/

EIE 415 Nonlinear Control System

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To demonstrate non-linear system behavior by phase plane and describing function methods
- To perform the stability analysis nonlinear systems by Lyapunov method develop design skills in optimal control problems
- To understand the Non-linear control design technique.
- To analyze the Non-linear system with analytical technique.

Section A

Introduction to Nonlinear Control: Characteristics of nonlinear systems, common nonlinearities in control systems, linearization approximations- Taylor series method and Jacobian method, effect of linearization on nonlinear system performance, analytical method of analysis: Poincare perturbation method.

Section B

Describing Function Analysis: Describing functions of common nonlinearities use of the describing function to determine system stability.

Phase Plane Analysis: Phase portraits, singular points, construction of phase portraits, method of isoclines, delta method, jump resonance, limit cycles, existence of limit cycles, Poincare-Bendixson theorem, and evaluation of time from phase trajectory.

Section C

Lyapunov's method of Analysis: Nonlinear systems and equilibrium points, concepts of stability, local stability, Lyapunov's direct method, and equilibrium point theorems, Krasovskii's method- Variable gradient method.

Nonlinear Control System Design: Sliding mode control, model reference adaptive control.

Text Books:

1. Slotine, J.E. (1991). *Applied Nonlinear Control*. New Jersey,Prentice Hall
2. Vidyasagar, M. (1978). *Nonlinear System Analysis*. New Jersey, Prentice Hall.
3. Gopal,M. (2003). *Digital Control & State variable Methods*. Tata-Mc-Graw hill.

e-Resources:-

1. https://nptel.ac.in/courses/108106024/
2. http://web.mit.edu/nsl/www/videos/lectures.html
3. https://ocw.mit.edu/courses/mechanical-engineering/2-003-modeling-dynamics-and-control-i-spring-2005/study-materials/nonlinear_cont/
4. https://web.stanford.edu/class/engr209a/

EIE 402 Digital Control System

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes

The Students will be able to:

- To have in-depth knowledge and critical understanding of the theory and principles of digital control systems and their applications
- To distinguish the specific characteristics and differences of discrete/digital, hybrid and analog systems.
- To transform an analog system to discrete and vice versa
- To analyze the behavior of a discrete system in time domain and in frequency domain
- To design and synthesize controllers that will be implemented using digital hardware.
- To apply digital control systems' principles and techniques to discrete or continuous time systems.

Section A

Signal Processing in Digital Control: Basic digital control system, advantages of digital control and implementation problems, basic discrete time signals, z- transform and inverse z-transform, modeling of sample-hold circuit. Pulse transfer function, solution of difference equation by z-Transform method.

Design of Digital Control Algorithms: Steady state accuracy, transient response and frequency response specifications, digital compensator design using frequency response plots and root locus plots.

Section B

State Space Analysis and Design: State space representation of digital control system, conversion of state variable models to transfer functions and vice versa, solution of state difference equations, controllability and observability design of digital control system with state feedback.

Section C

Stability ofDiscrete System: Stability on the Z-plane and Jury stability criterion, bilinear transformation, Routh stability criterion on rth plane,

Lyapunov's Stability in the sense of Lyapunov's, stability theorems for continuous and discrete systems, stability analysis using Lyapunov's method.

Optimal digital control: Discrete Euler Lagrange equation, max. min principle, optimality Dynamic programming, Different types of problem and their solutions.

Text Books:

1. Slotine, J.E. (1991). *Applied Nonlinear Control*. New Jersey,Prentice Hall
2. Vidyasagar, M. (1978). *Nonlinear System Analysis*. New Jersey, Prentice Hall.
3. Gopal,M. (2003). *Digital Control & State variable Methods*. Tata-Mc-Graw hill.

Reference Books:

1. Slotine, J.E. (1991). *Applied Nonlinear Control*. New Jersey,Prentice Hall
2. Gopal,M. (2003). *Digital Control & State variable Methods*. Tata-Mc-Graw hill.
3. Vidyasagar, M. (1978). *Nonlinear System Analysis*. New Jersey, Prentice Hall.

e-Resources:

1. https://nptel.ac.in/courses/108103008/
2. https://ocw.mit.edu/courses/mechanical-engineering/2-171-analysis-and-design-of-digital-control-systems-fall-2006/

EIE 401 Analytical Instrumentation

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To understand the basic principles & importance of Analytical Instruments in industrial process plants

- To understand the use of block diagrams for the design of analytical and industrial instruments.
- To understand the importance and application of various chromatographic techniques.
- To understand the importance of Environmental Pollution monitoring instruments.

Section A

UV-Visible Spectroscopy: Introduction, Electromagnetic Radiation and Spectrum, Beer's Law, Atomic techniques-emission, absorption and fluorescence, Radiation Sources: Continuum Sources, Line Sources and Laser Sources. Wavelength selectors: Optical Filters and Monochromators, Sample Holder, Radiation Detectors: Photon Transducers (Phototube,Photo voltaic cell and Photomultiplier tube) and Thermal Transducers (Thermocouple, Bolometer,Pyroelectric transducer). Colorimeters. Block diagram of Single Beam and Double Beam Spectrophotometer. Infrared Spectroscopy: IR Sources and detectors, Types of IR spectrophotometers, FT-IR Spectrometer, Dispersive Spectrometry using monochromators.

Section B

Spectroscopic Analysis: Mass Spectrometers, X-Ray Spectrometer, Photo-Acoustic Spectroscopy, Flame Spectrometer, NMR Spectrometer.

Liquid Analysis: pH meter, Conductivity meter, dissolved oxygen analysis, Polarography- Apparatus, Circuits techniques-pulse polarography and applications, Electrodes-Ion Selective, Molecular selective types-their variations and application.

Gas Analysis: Paramagnetic Oxygen Analyzer, Thermal Conductivity Analyzer, Infrared Gas Analyzer, Chemiluminescene Analyzer.

Section C

Chromatography: Basic parts of Gas Chromatography, Types of Columns, Detection Systems: thermal conductivity. Flame ionization, Electron capture detector. Liquid Chromatography: Types of Liquid chromatography (Paper and Thin Layer). Types of columns and detection systems of Liquid Chromatography.

Environmental Pollution Monitoring: Air pollutants, Air pollution monitoring instruments-carbonmonoxide, sulphur dioxide, nitrogen oxide,

hydrocarbon and ozone. Smoke monitor, Dust monitor, visible emission monitoring system.

Text Books:

1. R.K. Jain, "Mechanical and Industrial Measurements", Khanna Publications
2. R.S.Khandpur, "Handbook of Analytical Instruments", TMH New Delhi.
3. D.A. Skoog, "Principles of Instrumental Analysis", Saunders College Publishing, Philadalphia.

Reference Books:

1. H. H. Williard, L. LMeritt, J.A.Dean and F.A.Settle, "Instrumental Methods of Analysis", CBS Publishers, Delhi.
2. D. Patranabis, "Prinicples of Industrial Instrumentation", TMH, New Delhi.

e-Resources:

1. https://nptel.ac.in/courses/103108100/15
2. https://nptel.ac.in/courses/103108100/
3. https://ocw.mit.edu/courses/biological-engineering/20-309-biological-engineering-ii-instrumentation-and-measurement-fall-2006/

EIE 413 Fiber Optic and Laser Instrumentation

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To recognize and classify the structures of Optical fiber and types.
- To discuss the channel impairments like losses and dispersion.
- To analyze various coupling losses.
- To classify the Optical sources and detectors and to discuss their principle.
- Tofamiliar with Design considerations of fiber optic systems.

- To perform characteristics of optical fiber, sources and detectors, design as well as conduct experiments in software and hardware, analyze the results to provide valid conclusions.

Section A

Fiber optical waveguides, different types of fibers and their properties, Dispersion, losses optical fiber connectors, measurement of fiber characteristics: attenuation, dispersion' refractive index profile, optical time domain reflectometer. Light emitting diode: radiative recombination, LED materials, constructions & response time. Junction detectors: p-n and p-i-n photodiode, response times, APD.

Section B

LASER: Emission and absorption of radiation, Einstein relation, Absorption of radiation, Population inversion, Optical feedback, Threshold conditions, line shape functions, laser modes, Class of lasers:, solid state, semiconductors, gas & liquid laser. Single'mode operation, Q-switching & mode locking. Laser for measurement of distance and velocity.

Section C

Fibre optic sensors: measurement of length, displacement, pressure, temperature, current voltage, liquid level, fiber optic gyroscope. Holography: basic principle and applications, Laser in material processing: interaction of high-power laser beams with materials, laser welding, cutting, hole drilling and trimming of materials.

Text Books:

1. Wilson & Hawkes: Opto Electronics, an introduction. III edition, PHI Publication
2. James T. Luxon, David E. Parker, Industrial lasers and their applications, Prentice- Hall International.

Reference Books:

1. John M. Senior: Optical Fiber Communication, III edition, PHI Publication.
2. John F Read, Industrial applications of lasers, Academic Press, 1978.

e-Resources:

1. https://swayam.gov.in/course/3545-fiber-optics
2. https://nptel.ac.in/courses/115107095/

3. https://ocw.mit.edu/resources/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/fiberoptics-fundamentals/

EIE 301 Biomedical Instrumentation

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To describe the origin of biopotentials and explain the role of biopotential electrodes;
- To inspect common biomedical signals and distinguish characteristic features;
- To identify common signal artifacts, their sources and formulate strategies for their suppression;
- To outline the design of cardiac pacemakers, neurostimulators and defibrillators;
- To explain and contrast measurement principles for blood flow, pressue and volume as well as respiratory variables
- To define and discuss biochemical sensors; andIdentify, explain and judge patient safety issues related to biomedical instrumentation.

Section A

Electrode electrolyte interface, hall-cell potential, polarization and non-polarisable electrode electrode-metal micropipette Ag-Cl electrodes Microelectrodes, skin surface electrode, and lead for EG, ECG EMG Transducer for biomedical applications, factors governing the selection of transducer pressure temperature, flow, biomedical ultrasonic transducer.

Section B

Noise preamplifier, main amplifier and driver amplifier, inkjet recorder thermal array recorder, photographic recorder, magnetic tape recorder, X-Y recorder, medical oscilloscope pH, PO, PCO2, PHCO3, Electrophoresis colorimeter, spectrophotometer, flame photometer, auto analyzer.

Section C

Respiration, heart rate, temperature, pulse blood pressure, cardiac output 02, CO2 measurements. Measurement of blood pressure, blood flow, and heart sound, cardiograph: Phonocardiography, vector cardiography, Echocardiography pacemaker. Defibrillators, Ventilator, Computer patient monitoring system.

Text Book:

1. Cromwell. L. (2015). *Biomedical Instrumentation and measurement* (2nd ed.). New Delhi: Pearson Education India.

Reference books:

1. Webster, J. G. (2015). *Medical Instrumentation Application and Design* (4th ed.). New York: John Wiley and sons.
2. Khandpur, R.S. (2014). *Handbook of Biomedical Instrumentation* (3rd ed.). New Delhi: Tata McGraw-Hill.
3. Carr, J. J. & Brown, J. M. (2002). *Introduction to Biomedical equipment Technology*(4th ed.). New York: John Wiley and sons.

e-Resources:

1. https://nptel.ac.in/courses/108105101/
2. https://nptel.ac.in/courses/117108037/15
3. https://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-for-biomedical-applications-spring-2006/
4. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-590-biomedical-engineering-seminar-series-developing-professional-skills-fall-2006/

EIE 306 Virtual Instrumentation

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To recognize the components of virtual instrumentations and apply them for PC based measurement.
- To understand the basics of interfacing of VI and get an adequate knowledge of virtual instrumentation.

- To write VI programs for different applications and employ LabVIEW software for control, measurement and data acquisition.
- To understand the common instrument interfaces with their industrial specification and standards.
- To interface the supporting hardware of VI with LabVIEW and develop computer based control system.

Section A

Virtual Instrumentation: Historical perspectives, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, and comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems. Embedded Controller, OPC, HMI / SCADA software, Active X programming.

VI programming techniques: VIS and sub-VIS, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

Section B

Data acquisition basics: Introduction to data acquisition on PC, Sampling fundamentals, Input/ Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

VI Chassis requirements. Common Instrument Interfaces: Current loop RS 232C/ RS485, GPIB.

Section C

Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI.

Networking basics for office & Industrial applications, VISA and IVI.

VI toolsets. Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system.

Simulation of systems using VI, Development of Control system. Industrial Communication, Image acquisition and processing. Motion control.

TEXT BOOKS:

1. Gary Johnsongv, Lab VIEW Graphical Programming, 2nd edition, McGraw Hill, Newyork, 1997.
2. Lisa K. wells & Jeffrey Travis, Lab VIEW for everyone, Prentice Hall, New Jersey, 1997.

REFERENCES:

1. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.

e-Resources:

1. http://www.ni.com/en-in/innovations/white-papers/06/virtual-instrumentation.html
2. http://www.ni.com/training/labview/

EIE 417 Power Plant Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To understand the basics related to Power Plants.
- To differentiate types of Power Plants.
- To describe the different components related to Power Plants.
- To understand the working of Steam, Diesel, Gas, and Nuclear power plants.
- To know about Unconventional Methods of Power Generation.

Section A

Introduction: Introduction to generation of electrical power, sources of energy, comparative merits, principal types of power plants.

Steam Power Plants: Selection of site, general layout of plant. Rankine cycle with regeneration, reheat, intercooling. Condensers, spray ponds and cooling towers, feed water treatment.

Hydro Electric Power Plants: Site selection, classification, different types of hydroelectric power plants and their field of use. General layout of storage type of plant. Prime movers, selection of turbine.

Section B

Diesel Power Plants: Fields of use, components of diesel electric power plant, types of diesel engines used, performance of diesel electric power plant, comparison with steam power plants.

Gas Turbine Power Plants: Components of gas turbine power plant, open cycle and closed cycle plants with regeneration, reheat, intercooling. Choice of working fluid, arrangement of plant components. Combined gas and steam power plant. Comparison with diesel and steam power plants.

Section C

Nuclear power plants: selection of site, nuclear reaction, fission process and chain reaction, constituents of power plant and layout, nuclear reactor, working, classification, control, shielding and waste disposal.

Unconventional Methods of Power Generation: Introduction to solar energy and its utilization, solar cells, thermo-electric and thermionic devices, fuel cells, magneto hydrodynamic energy conversion, geothermal, tidal and wind power plants.

Text Book:

1. Domkundwar, S. &Arora,S. C. (1996). *A course in power plantengineering*. DhanpatRai& Sons, Delhi.
2. Nag,P.K. (2006). *Power Plant Engineering*. TMH.

Reference Books:

1. Skrotzki, (1966). *Power Station Engineering &Economy.*McGraw Hill

e-Resources:

1. https://nptel.ac.in/courses/108105058/8
2. https://ocw.mit.edu/courses/energy-courses/
3. https://nptel.ac.in/courses/112107216/
4. https://www.coursera.org/lecture/thermodynamics-intro/07-01-example-of-analysis-of-a-rankine-power-plant-part-1-assigning-the-state-RKEsQ
5. https://nptel.ac.in/courses/121106014/

EEE 401 Electrical Drives and Control

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes

The Students will be able to:

- To understand definition, scope, objectives, and limitation of electric drives, power transistor and SCR.
- To analyze the construction and characteristics and application of D.C. motor.
- To analyze the construction and characteristics and application of three phase induction motor .
- To analyze the speed control methods of A.C. and D.C. motor
- To analyze the construction and characteristics and application of sensor, transducer and switches.
- To analyze the industrial applications of electric drives.

Section A

Fundamentals of Electric Drive: Construction, advantages and classification, speed-torque conventions and multi-quadrant operations, constant torque and constant power operation.

Types of load torque: Components, nature and classification, load equalization.

Dynamics of electric Drive: Dynamics of motor-load combination, steady-state and transient stability of electric Drive.

Selection of Motor Power rating: Thermal model of motor for heating and cooling, classes of motor duty, determination of motor power rating for continuous duty, short time duty and intermittent duty.

Section B

Electric Braking: Purpose and types, braking of DC motor, three phase induction and synchronous motors. **Dynamics during Starting and Braking:** Calculation of acceleration time and energy loss during starting of dc shunt and three phase induction motors, methods of reducing energy loss during starting, energy relations during braking, dynamics during braking.

Power Electronic Control of DC Drives: Single phase and three phase controlled converter fed separately excited dc motor drives (continuous conduction only), dual converter fed separately excited dc motor drive, rectifier control of dc series motor, supply harmonics, power factor and ripples in motor current, chopper control of separately excited dc motor and dc series motor.

Section C

Power Electronic Control of AC Drives: Three phase induction motor drive, static voltage control scheme, static frequency control scheme (VSI, CSI, and cyclo-converter based) static rotor resistance and slip power recovery control schemes.

Three Phase Synchronous motor: Self-controlled scheme.

Special Drives: Switched reluctance motor, brushless dc motor, selection of motor for particular applications.

Text Books:

1. Dubey, G.K. (2002). *Fundamentals of Electric Drives (2nd ed.).*Narosa Publishing House.
2. Pillai, S.K. (2012). *A First Course on Electric Drives (3rd ed.).* New Age International.
3. Bose, B. K.(2006). *Power Electronics and Motor Drives (1st ed.).*Academic Press.

Reference Books:

1. Chilkin, M. (2012). *Electric Drives".* Mir Publishers, Moscow.
2. Mohammed A. E. (2008). *Fundamentals of Electric Drives.* Thomson Asia, Pvt. Ltd. Singapore.
3. De N.K. and Prashant (2007) K.S. *Electric Drives.* Prentice Hall of India Ltd.
4. Subrahmanyam, V. (2005) *Electric Drives: Concepts and Applications.* Tata McGraw Hill.

E- Resources:

1. https://nptel.ac.in/courses/108102046/
2. https://nptel.ac.in/courses/108104011/
3. http://www.vssut.ac.in/lecture_notes/lecture1424084684.pdf
4. https://nptel.ac.in/courses/108108077/

EEE 401L Electrical Drives and Control Lab

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	2	1

Learning Outcomes

The Students will be able to:

- To understand definition, scope, objectives, and limitation of electric drives, power transistor and SCR.
- To analyze the construction and characteristics and application of D.C. motor.
- To analyze the construction and characteristics and application of three phase induction motor.
- To analyze the speed control methods of A.C. and D.C. motor
- To analyze the construction and characteristics and application of sensor, transducer and switches.
- To analyze the industrial applications of electric drives.

LIST OF EXPERIMENTS

l. Modeling and simulation of armature voltage control of DC drive.

2. Modeling and simulation of speed control of chopper fed DC drive.

3. Modeling and simulation of speed control of fully controlled rectifier fed DC drive.

4. To obtain four quadrants operation of dual converter fed DC drive.

5. To control speed of DC drive through microcontroller.

6. To control speed of three phase Induction motor drive through microcontroller.

7. To control speed of SRM drive through microcontroller.

8. To control speed of PMSM drive through microcontroller.

MCTR 402 Mechatronics

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes

The Students will be able to:

- To develop skills to monitor and control real world industrial systems
- To implement projects for industrial and home automations
- To analyze and create own innovative filters and signal conditioning applications
- To perform computer based controlling of industries using PLC, SCADA and HMI.

Section A

Mechatronics and its scope: Displacement, position & proximity, Velocity, force, Pressure and level. Signal conditioning: amplification, filtering, Elements of Microprocessors & Microcontrollers**,**

Programmable Logic controllers, Communication interface.

Section B

Pneumatic and Hydraulic actuation systems: Directional control valves. Pressure control valves and cylinders. Process control valves

Mechanical actuation system: kinematic chains, cams, gear-trains, Ratchet & Pawl, dampers, Bearings,

Electrical actuation system: Mechanical switches- solenoid operated solid state switches, DC, AC & stepper motors. Building blocks of Mechanical spring, mass and damper

Drives- Electrical Drives Fluid systems, hydraulic, servo Closed loop controllers.

Section C

Case Studies of Mechatronic Systems: Industrial Robot and its control, Automobile Engine Control, Electromechanical disc-control, Vehicle Suspension Control, Micro Mechanical Systems, Computer Printer, VCR, Fax Machine, NC Machine**.**

Text Books:

1. Rolf, I. (2005).Mechatronics Systems Fundamentals. Springer.

2. Bolten, W. (2003). Mechatronics. Pearson/Prentice Hall.
3. Sawhney, A. K. (2004).A Course in Electrical & Electronic Measurements & Instrumentation. Dhanpat Rai & Company Publication.
4. Nakra, B. C., Chaudhry, K.K. (2010). Instrumentation, Measurement and Analysis. Tata McGraw-Hill Education.

E- Resources:

1. https://nptel.ac.in/courses/112103174/
2. https://onlinecourses.nptel.ac.in/noc17_me31/preview
3. https://ocw.mit.edu/courses/mechanical-engineering/2-737-mechatronics-fall-2014/

MCTR 402L Mechatronics Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes

The Students will be able to:

- To simulate the basic electric, hydraulic and pneumatic system using simulation software.
- To develop an understanding of plc ladder diagram related to industrial automation systems and measure its performance.
- To design Mechatronics system according to an Industrial Applications.
- To combine the real time control systems with peripheral devices through programmable interface techniques..

LIST OF EXPERIMENTS

1. Study of Modular Mechatronics System (MMS) and its components.
2. To design and assemble the components of distribution or feeding station.
3. To design and assemble the components of testing station.
4. To design and assemble the components of sorting station.
5. To study different modes of operation of a six axis industrial robot.

6. To study about Selective Compliance Articulated Robotic Arm (SCARA) station.
7. To study about IOT and RFID application in Mechatronics System.
8. To study and control different parameters in process automation.

MCTR 403 Robotics and Automation

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To develop skills of creating industrial and mobile robot projects
- To implement robots like KUKA, PUMA in real industrial world
- To create innovative robot designs using mathematical concepts of kinematics
- To develop autonomous mobile robots in surveillance, security, home and office services.

Section A

BASIC CONCEPTS-Automation and Robotics-An overview of Robotics, Present and future applications - classification by coordinate system and control system, Dynamic stabilization of Robotics.

POWER SOURCES AND SENSORS- Hydraulic, Pneumatic and electric drivers-Determination HP of motor and gearing ratio, variable speed arrangements, Path Determination-Machinery Vision- Ranging-Laser acoustic, Magnetic Fiber Optic and Tactile Sensor.

Section B

MANIPULATORS- Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and Pneumatic manipulators.

ACTUATORS AND GRIPPERS-Pneumatic, Hydraulic Actuators, Stepper Motor Control Circuits, End Effector, Various types of Grippers, Design consideration.

Differential transformation and manipulators, Jacobians-problems. Dynamics: Lagrange-Euler and Newton-Euler formations - Problems.

Section C

KINEMATICS -Forward and Inverse Kinematic Problems, Solutions of Inverse Kinematic problems, Multiple Solution, Jacobian Work Envelop-Hill Climbing Techniques.

PATH PLANNING-Trajectory planning and avoidance of obstacles, path programming, languages and software packages. planning, Skew motion, joint integrated motion-straight line motion - **Rol CASE STUDY**- Multiple Robots - Interface Robots in Manufacturing and Non-Manufacturing applications- Robot Cell Design Selection of a Robot.

Text books:

1. Groover,M. P.(2017). *Industrial Robotics: Technology, Programming, and Applications* (2nded.). Pearson Education.
2. Niku, S. B. (2011). *Introduction to Robotics* (2nded.). Wiley.
3. Fu, K.S., Lee,C.S. G. &Gonzalez, R. (1987) . *Robotics: Control,Sensing, vision and intelligence*. Tata McGraw-Hill Education
4. Mittal, R.K.&Nagrath, I. J.(2018). *Robotics and Control*. Tata McGraw-Hill Education.

References books:

1. Craig, J. J. (2008). *Introduction to Robotics: Mechanics and Control* (3rded.). Pearson Education.
2. Spong, M. W. &Vidyasagar, M. (2008). *Robot Dynamics and Control*. John Wiley & Sons.
3. Siciliano , B. & Sciavicco, L. (2010). *Robotics: Modelling, Planning and Control*. Springer.

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc18_me61/preview
2. https://swayam.gov.in/courses/4859-july-2018-robotics
3. https://www.edx.org/learn/robotics
4. https://www.coursera.org/specializations/robotics

MCTR 403L Robotics and Automation Lab

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	2	1

Learning Outcomes

The Students will be able to:

- To develop skills of creating industrial and mobile robot projects
- To implement robots like KUKA, PUMA in real industrial world
- To create innovative robot designs using mathematical concepts of kinematics
- To develop autonomous mobile robots in surveillance, security, home and office services.

LIST OF EXPERIMENTS

1. Implementation of D-H Parameters on Robo Analyzer software.
2. Implementation of Forward Kinematics on Robo Analyzer Software.
3. Implementation of Inverse Kinematics on Robo Analyzer Software.
4. Implementation and study of KUKA-Sim simulator/HMI Interface.
5. Implementation on Hardware (KR-16).
6. Implementation of Sensor Fusion on Robotino Software and hardware.
7. Implementation of Path Tracking on Robotino Software and hardware.
8. Study of TAL BRABO Robot with practical implementation.

EEE 409 Power System Operation and Control

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcome:

The Students will be able to:

- Understand the techniques to control power flows, frequency and voltage.
- Explore the significance of voltage control.
- Understand the concept of flexible AC transmission and the associated problems.

- Learn the power system security and its application as a system operator.

Section A

Automatic Generation and Voltage Control: Introduction; Load Frequency Control (Single Area Case); Load Frequency Control and Economic Dispatch Control; Two-Area Load Frequency Control; Optimal (Two-Area) Load Frequency Control; Automatic Voltage Control; Load Frequency Control with Generation Rate Constraints (GRCs); Speed Governor Dead-Band and Its Effect on AGC; Digital LF Controllers; Decentralized Control.

Power System Security: Introduction; System State Classification; Security Analysis; Contingency Analysis.

Section B

Reactive Power and Voltage Control: Introduction; Reactive power requirement of an uncompensated line; Implication of surge impedance loading; Reactive loss characteristics of transmission line; Operation of a transmission line at no load condition; Operation of a transmission line under heavy loading condition; Voltage regulation of the transmission line and its relation with reactive power; Maximum power transfer in an uncompensated line; Line loadability.

Section C

FACTS: The concept of flexible AC transmission - reactive power control in electrical power transmission lines -uncompensated transmission line – series and shunt compensation. Overview of FACTS devices - Static VAR Compensator (SVC) – Thyristor Switched Series capacitor (TCSC) – Unified Power Flow controller (UPFC) - Integrated Power Flow Controller (IPFC)

Recommended Text Books

1. Grainger, J. J., Stevenson, W. D. (2017), "*Power System Analysis*" (1st Edn.) McGraw Hill, USA.
2. Kothari, D. P., Nagrath, I. J. (2003), "*Modern Power System Analysis*"(3rdEdn.) McGraw Hill
3. Chakrabarti, A.,Kothari, D. P., Mukhopadhyay, A. K., De, A.(2010), "*An introduction to Reactive Power Control and Voltage Stability in Power Transmission Systems*" , PHI

4. Venkatesh, P., Manikandan, B. V., Raja, S. C., Srinivasan, A. (2012), *"Electrical Power Systems",* PHI

Recommended Reference Books

1. Wood, A. J.,Woolenberg, B. F., (2014), "*Power Generation Operation and Control*", John Wiley and Sons
2. Saadat, H. (2002), "*Power System Analysis*", (2nd Edn.) McGraw Hill
3. Singh, L. P., (2012) "*Advanced Power System Analysis and Dynamics*" (2nd Edn.), New Age International

Recommended e-Resources

1. http://nptel.ac.in/courses/108101040/
2. http://www.electrical-engineering-portal.com/
3. http://nptel.iitm.ac.in/courses.php
4. www.vlab.co.in

EEE 409L Power System Operation and Control Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcome:

The Students will be able to:

- Understand the techniques to obtain transmission line parameters.
- Explore the significance of voltage control.
- Perform the study of frequency control.
- Learn the economic load dispatch optimization from the perspective of system operator.

List of Experiments

1. Measurement of ABCD parameter of Transmission Line using MATLAB.
2. Modelling Single Area and Multi Line Load Frequency control using MATLAB Simulink.
3. Calculate the inductance and capacitance of different type of transmission line configuration

4. Calculation of Vs, Vr, line losses and power factor of short transmission line.
5. Calculation of Vs, Vr, line losses and power factor of medium transmission line.
6. To solve swing equation by point by point method
7. To solve the economic load dispatch problem

EEE 410 Power System Restructuring and Deregulation

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

The Students will be able to:

- Familiarize with concepts and need for deregulated power systems.
- Solve market based power flow and unit commitment problems.
- Understand power market development in India and across the world.

Section A

Traditional Power Industry: structure, motivations for restructuring, restructuring process, Market Model: monopoly model, purchasing agency model, wholesale competition model, retail competition model. Comparison of market models, Electricity Vs other commodities, Components of restructured systems, Key Market Entities- ISO, TSO, GENCO, TRANSCO, DISCO, RETAILCO, Functions and responsibilities, Trading arrangements: pool, bilateral & multilateral, Open Access Transmission Systems & Distribution Systems.

Fundamentals of Deregulation: Need and conditions for deregulation, Components of Deregulation, Technical, economic & regulatory issues involved in deregulation of power industry. Privatization, Competition in the electricity sector, conditions, barriers, different types, benefits and challenges, Reregulation.

Basics of Public Good Economics: consumer behaviour, supplier behaviour, market equilibrium, short-run and long-run costs, different cost of production and perfectly competitive market.

Section B

Power system Operation in Restructured Markets: Coordinated real time dispatch through balancing mechanism, Imbalance settlement methodologies. Transmission Congestion Management: methodologies, Nodal pricing. Available Transfer Capability Evaluation and Methodologies.

Electricity Markets Pricing: Market Clearing price, Zonal and locational market clearing price, Locational Marginal Prices (LMP), LMP formulation and Implementation, LMP using AC optimal power flow, LMP using DC optimal power flow, Price based unit commitment and power flow.

Section C

Ancillary Services: Classifications and definitions, Market for ancillary services, load generation balancing related services, voltage control and reactive power support services, black start capability service, co-optimization of energy and reserve services.

Power market development in India: Institutional structure in Indian Power sector, generation, transmission and distribution utilities. Availability based tariff, electricity act 2003, open access, Power Exchanges.

Recommended Text Books

1. Shahidehpour, M., Yamin, H., & Li, Z. (2003). *Market operations in electric power systems: forecasting, scheduling, and risk management*. John Wiley & Sons.
2. Kirschen, D. S., & Strbac, G. (2018). *Fundamentals of power system economics*. John Wiley & Sons.
3. Bhattacharya, K., Bollen, M. H., & Daalder, J. E. (2012). *Operation of restructured power systems*. Springer Science & Business Media.
4. Lai, L. L. (Ed.). (2001). *Power system restructuring and deregulation: trading, performance and information technology*. John Wiley & Sons.

Recommended Reference Books

1. Stoft, S. (2002). *Power system economics: designing markets for electricity*", Wiley Interscience.
2. Gilbert, R. J., & Kahn, E. P. (Eds.). (2007). *International comparisons of electricity regulation*. Cambridge University Press.

3. Rothwell G, Gomez T. (Eds.) (2003). *Electricity Economics Regulation and Deregulation*. IEEE Press Power Engineering Series, John Wiley & Sons.

Recommended e-Resources

1. https://nptel.ac.in/courses/108101005/65#
2. http://edu.epfl.ch/coursebook/en/power-system-restructuring-and-deregulation-EE-570
3. https://www.e-education.psu.edu/eme801/node/534

EEE 410L Power System Restructuring and Deregulation Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcome:

The Students will be able to:

- Understand different commercial software tools used for power system studies.
- Solve different problems related to power system operation.
- Understand congestion management in power system.

List of Experiments

1. Formulate and solve price based unit commitment problem.
2. Modeling of DC optimal power flow problem in power system software.
3. Modeling of AC optimal power flow problem in power system software.
4. Calculation of locational and zonal marginal prices using different methods.
5. Calculation of Available Transfer Capability for a given power system.
6. Modeling of congestion management methods in power system software.
7. Modeling and simulation of co-optimization of energy and reserve services.

MCTR 420 Operation Research

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To understand the basics of Linear Programming.
- To describe the different types of Inventory Models.
- To understand the Transportation and Assignment problem and application.
- To know about Game Theory problem and application.

Section A

Introduction: Characteristics and scope of O.R., formulations of problem and methodology.

Linear Programming: Mathematical formulation of problem, graphical solution. Simplex and revised simplex methods, unrestricted and bounded variables, degeneracy and cycling, perturbation methods. Duality. Sensitivity analysis.

Section B

Transportation and Assignment: LP formulation; Transportation algorithm; Hungarian algorithm.

Game Theory: Pure and mixedstrategies; Graphical solution; Dominance; LP formulation.

Section c

Inventory Models: Elements of costs, lead time, inventory control techniques, ABC analysis. Economic lot size problems with deterministic demand and supply rate including considerations of shortages and price breaks. Buffer stock, reorder level and reorder point. Economic run length.

Text Book:-

1. Taha,H.A. *Operations Research- An Introduction.* PHI.

2. Khanna,O. P.(2018).*Industrial Engineering and Management*. Dhanpat Rai Publications

Reference Book:-

1. Swarup, K. Gupta,P. K. &Mohanm, M. *Operations Research*. Sultan Chand & Sons.
2. Hiller &Liberman. *Introduction to Operations Research*. San Francisco, Holden Day Inc.

e-Resources:

1. https://nptel.ac.in/courses/112106134/
2. https://www.coursera.org/learn/wharton-operations
3. https://swayam.gov.in/courses/5746-operation-research
4. https://nptel.ac.in/courses/112106131/

MCTR 413 Industrial Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To understand the basics of Management and Management structure.
- To interpret about Production Planning and Control, Work Study.
- To differentiate types of cost.
- To describe the different type of Plant Layout.
- To understand the Material Handling.
- To know about network techniques, CPM and PERT, time estimates.

Section A

Introduction: Historical development, functional areas of business and the need for integrating these through the development of business goals.

Management: Principles and elements of management. Functions of management, planning, organization, staffing, directing, coordination and control. Types and levels of management, management structure. Scientific

management, development of management thought with reference to the work of Taylor, Gilberth, Mayo and Kurt Lewin.

Elements of costing and financial statements: Classification of costs, direct and indirect cost, labour, material and over-head, Prime cost, factory cost, fixed cost, variable cost, increment cost, Allocation of overhead costs. Analysis of Break even chart.

Section B

Plant Layout: Principles of plant layout, use of travel charts. Flow Pattern, Process Layout and Product Layout and combination, Line balancing.

Materials Handling: Functions, engineering and economic factors, relationship to plant layout. Selection, operation and maintenance of material handling equipment. Types of equipment

Production Planning and Control: Types of production, Function of production planning and control, planning. Pre-planning, sales forecasting, routing, scheduling, dispatching and control, Gantt charts.

Section C

Work Study: Concept of productivity, method study, motion economy, process chart symbols. Flow diagram, operation analysis and operation chart, SIMO charts. Work measurement, use of stop watch procedure for time study data. Use of time study data with practical applications. Performance rating.

Introduction to network techniques, CPM and PERT, time estimates.

Text Book:-

1. Mahajan, M. *Industrial Engineering and Production Management*. Dhanpat Rai & Sons. Delhi.
2. Banga& Sharma. *Engineering Economics and Industrial Organization*. Khanna Publishers.

Reference Book:-

1. Philippo. *Principles of Personnel Management*. McGraw Hill.
2. Buffa. (2007). *Operations management*. Wiley.

e-Resources:-

1. https://nptel.ac.in/courses/112107142/
2. https://www.coursera.org/specializations/supply-chain-management
3. https://nptel.ac.in/courses/112107143/

4. https://www.edx.org/micromasters/principles-manufacturing

MCTR 417 Manufacturing Science

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To understand the Metal Cutting and force analysis in the operation.
- To interpret about Hot and Cold working.
- To differentiate among the Modern Machining Methods.
- To describe the different Bulk Deformation Processes.
- To know about Production of Machine Components.

Section A

Metal Cutting: Machining operations – types, elements and cutting conditions; Theory of chip formation and chip flow – shear angle;Orthogonal and Oblique cutting; Geometry and designation of single point cutting tool, milling cutters, twist drill, broaches; Form tools.

Merchant's Force Analysis: Forces, Stresses and Power consumption in orthogonal cutting; Velocities, Strain (rate), Specific cutting energy.

Section B

Metal Working: Metal behavior in metal forming – Principal stresses and strains, Plastic deformation and Yielding criteria; Hot and Cold working.

Bulk Deformation Processes: Forging – Open and Closed die, Impression, Drop, Upset and Press forging; rolling. Extrusion – Forward, Backward and Impact extrusion; Wire, Rod and Tube drawing. Sheet Metal Working: Cutting –Shearing, Blanking, Punching; Drawing; Bending; Spinning.

Section C

Modern Machining Methods: Classification; Abrasive and Water jet; Ultrasonic; Electrochemical; Chemical milling; Electricdischarge; Plasma arc machining.

Production of Machine Components: Processes of producing Shafts; Threads – Chasing, Rolling, Dies and Taps, Milling, Grinding;Gears – Casting, Stamping, Rolling, Milling, Shaping, Hobbing, Shaving, Grinding.

Text Book:-

1. Kalpakjian,Serope&Schmid,Steven.(2013) *Manufacturing Engineering & Technology* (7th ed.). Pearson
2. Sharma, P.C. (1999).*A Textbook of Production Engineering* (8th Revised edition) S Chand.

Reference Book:-

1. Pandey & Shan. *Modern machining Process*. TMH.
2. Ghosh, A. & Mallik, A. K. (2010). *Manufacturing Science*. India, PEARSON

e-Resources:-

1. https://nptel.ac.in/courses/112107145/
2. https://nptel.ac.in/downloads/112105127/
3. https://nptel.ac.in/courses/Webcourse-contents/IIT-ROORKEE/MANUFACTURING-PROCESSES/index.htm
4. https://nptel.ac.in/courses/112107145/
5. https://nptel.ac.in/courses/112105127/

MCTR 422 Production Technology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- To understand the foundation and design of gate riser system.
- To differentiate among types of Welding and related methods.
- To understand the working of Lathe, Shaper and drilling machine.
- To describe the different operation performed on Lathe, Shaper and Drilling machine.

Section A

Foundry: Classification of casting processes. Pattern types, materials, methods of construction and allowances. Core prints and core boxes. Moulding materials. Types and properties of moulding sands, sand additives, sand preparation.

Design principles of gating and risering systems, different types of gates and risers, riser location. Casting defects.

Section B

Welding: Classification of welding processes, metallurgy of weld. Oxyacetylene gas welding, equipment and tools used, types of flames, types of joint, various position welding. Other arc welding methods like carbon arc, metal inert gas (MIG), tungsten inert gas (TIG), atomic hydrogen, plasma, submerged, flux-cored, and electro slag arc welding.

Other welding and related methods: Resistance welding, Thermit welding, pressure welding, solid state welding methods. Brazing and soldering.

Section C

Lathes: Classification. Constructional details of centre lathe and its principal parts, accessories, attachments, and work holding devices. Main operations including taper turning and thread cutting.

Shaper: Classification. Constructional details and principal parts of standard shaper, quick return and feed mechanisms.

Drilling Machines: Classification. Constructional details of sensitive, pillar and radial drilling machines. Work and tool holding devices. Main operations.

Milling Machines: Types and classification. Constructional details and principle of operation of horizontal, vertical, and universal milling machines.

Text Book:-

1. Kalpakjian,Serope&Schmid,Steven.(2013) *Manufacturing Engineering & Technology* (7th ed.). Pearson
2. Sharma, P.C. (1999).*A Textbook of Production Engineering* (8th Revised edition) S Chand.

Reference Book:-

1. Pandey & Shan. *Modern machining Process*. TMH.
2. Ghosh, A. & Mallik, A. K. (2010). *Manufacturing Science*. India, PEARSON

e-Resources:-

1. https://nptel.ac.in/courses/Webcourse-contents/IIT-ROORKEE/MANUFACTURING-PROCESSES/index.htm

2. https://nptel.ac.in/courses/112104195/
3. https://nptel.ac.in/courses/112107144/
4. https://nptel.ac.in/courses/112105127/

ECE 408 Analytical Instrumentation

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain majorly pH conductivity & dissolved component analyzer, dissolved oxygen analyzer, sodium analyzer, silica analyzer and moisture measurement.
- Evaluate the performance of Spectro-photometers, FTIR Spectrometers and their applications.
- Describe modern trends in NMR Spectrometers, X-ray Spectrometry, and Mass Spectrophotometers with their applications.

Section A

PH conductivity & dissolved component analyzer Sampling systems – ion selective electrodes – conductivity meters – pH meters - dissolved oxygen analyzer – sodium analyzer – silica analyzer – moisture measurement.

GAS ANALYSER Oxygen analyzer – CO monitor, CO2, O2, dust and smoke measurement, thermal conductivity type–thermal analyzer–industrial analyzers.

Section B

Spectro photometers: Spectral methods of analysis – Beer's law UV – visible spectrophotometers – single beam and double beam instruments – source and detectors – IR spectrophotometers – sources and detectors – FTIR spectrometers – atomic absorption spectrophotometer – flame emission spectrophotometers – sources of flame photometry – applications.

Section C

Nuclear magnetic resolance and radiation techniques

NMR – basic principle – NMR spectrometers – applications – introduction to mass spectrophotometers – nuclear radiation detectors – GM counter –

proportional counter – solid state detectors, X-ray spectrometry: Instrumentation for X-ray spectrometry, X-ray diffractometer.

Recommended Books:

1. Willard., Merritt.Dean,& Settle. (2004). *Instrumental Methods of Analysis*. New Delhi: CBS Publishers & Distributors.
2. Ewing, Galen.W. (1985). *Instrumental Methods of Chemical Analysis*. New Delhi: McGraw-Hill Publication.
3. Liptak, B.G. (1995). *Process Measurement and Analysis*. Philadelphia: Chilton Book Company.
4. Settle,Frank.A. (1997). *Handbook of Instrumental Techniques for Analytical Chemistry*. New Delhi: PHI Publication.
5. Braun, Robert.D. (2012). *Introduction to Instrumental Analysis*. Hyderabad, Karnataka:BSP Books Pvt.Ltd.
6. Skoog. Holler.,&Crouch. (2017). Principles *of Instrumental Analysis*. New Delhi: Cengage Learning Publication.

Suggested e-resources:

1. **Modern Instrumental Methods of Analysis** by Prof. J. R. Mudakavi, Department of Chemical Engineering, Indian Institute of Science, Bangalore. https://nptel.ac.in/courses/103108100/

ECE 404 Optical Network

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Describe the important components such as multiplexer, filters.
- Explain the multiplexing technique
- Explain the signalling and routing of WDM network elements
- Describe the protection technique in SONET/SDH and IP network

Section A

Introduction to Optical Networks, Characteristics of Optical Fiber (Emphasis on Non Linear Characteristics) Timing & Synchronization,

Components: Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Tunable Lasers, Switches, Wavelength Converters, Networks SONET/SDH, Multiplexing, SONET/ SDH Layers, Frame, Structure, Frame Structure, Physical Layer, Elements of a SONET/SDH Infrastructure

Section B

ATM : Functions of ATM, Adaptation Layers, Quality of Service, Flow Control, Signaling and Routing, WDM Network Elements, Optical Line Terminals, Optical Line Amplifiers,

Optical Add/ Drop Multiplexers, Optical Cross Connects, WDM Network Design, Cost Trade-offs, Light path Topology Design, and Routing and wavelength assignment problems, Dimensioning Wavelength Routing Networks,

Section C

Network Survivability Basic Concepts, Protection in SONET/SDH, Protection in IP networks, Optical Layer Protection, Different Schemes, Interworking between Layers

Access Networks, Network Architecture Overview, Enhanced HFC, FTTC, Optical Switching, OTDM, Synchronization, Header Processing, Buffering, Burst Switching. Deployment Considerations

Recommended Books:

1. Ramaswami, Rajiv.,& Sivarajan, Kumar. N.(2009). *Optical Networks: A Practical Perspective*. *San Francisco,* California: Morgan Kaufmann Publisher.
2. Uyless, Black. (2009). *Optical Networks Third Generation Transport Systems***:** New Delhi: Pearson Publication.
3. Tanenbaum, Andrew. S. (2010). *Computer Networks***.** New Delhi: Pearson Publication.
4. Murthy, C. Siva Ram.,&Gurusamy Mohan. (2001). WDM, Optical Networks Concepts, Design & Algorithms**.** New Delhi: Pearson Publication.

Suggested e-resources:

1. **Introduction to Optical Networks** by Yatindra Nath Singh, Department of Electrical Engineering, Indian Institute of Technology, Kanpur. http://home.iitk.ac.in/~ynsingh/seminars/OptNets.pdf

2. **Optical Networks and Switching Systems** by Prof. Yatindra N Singh, Department of Electrical Engineering Indian Institute of Technology, Kanpur. https://nptel.ac.in/syllabus/117104021

ECE 406 Satellite Communication

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Identify the fundamentals of orbital mechanics, the characteristics of common orbits used by communications and other satellites.
- Understand the systems required by a communications satellite to function and the trade-offs and limitations encountered in the design of a communications satellite system.
- Understand the radio propagation channel for Earth station to satellite and satellite to satellite communications links, and the basics of designing antenna systems to accommodate the needs of a particular satellite system.
- Understand how analog and digital technologies are used for satellite communications networks and the topologies and applications of those networks, as well as the comparison to alternative communications systems.

Section A

Elements of Satellite Communication, Orbital mechanics, look angle and orbit determination, launches & launch vehicle, orbital effects, Geostationary Orbit, Satellite subsystems, attitude and orbit control systems, TTC&M, communication subsystem, satellite antenna, satellite link design: basic transmission theory, system noise temperature and G/T ratio, downlink design, uplink design, satellite systems using small earth station, design for specified C/N.

Section B

Modulation and multiplexing techniques for satellite links: FM, pre-emphasis and de-emphasis, S/N ratios for FM video transmission, digital

transmission, digital modulation and demodulation, TDM.Multiple access: FDMA, TDMA, DAMA and CDMA.

Section C

Error control for digital satellite links: error detection and correction, channel capacity, error control coding, convolutional codes, linear and cyclic block codes. Propagation effects and their impact on satellite-earth links: attenuation and depolarization, atmospheric absorption, rain, cloud and ice effects etc. Introduction of various satellite systems: VSAT, low earth orbit and non-geostationary, direct broadcast satellite television and radio, satellite navigation and the global positioning systems.

Recommended Books:

1. Bostian, Charles.,Pratt, Timothy., & Allnutt, Jeremy. (2006). *Satellite Communications***.** New Delhi: John Wiley & Sons.
2. Maral G., Bousquet M., Sun Z. (2010) *Satellite Communications Systems : Systems, techniques and technology,* 5th edition, , John Willy and sons.
3. Roddy, Dennis. (2017). *Satellite Communications***.** New Delhi:McGraw-Hill Publication
4. Ha, Tri. T. (1990). *Digital Satellite Communications.* New Delhi: McGraw-Hill Publication

Suggested e-resources:

1. **Satellite Communication Systems** by Prof. Kalyan Kumar Bandyopadhyay Department of Electronics and Electrical Communication Engineering Indian Institute of Technology, Kharagpur. http://textofvideo.nptel.ac.in/117105131/lec1.pdf
2. **Satellite Link Design** by Dr. Marwah Ahmed. https://net425site.files.wordpress.com/2017/02/net-425-d-feb-2016-lec-5.pdf

ELE 403 Basics of Nanoelectronics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Explain the fundamental science and quantum mechanics behind nanoelectronics.
- Explain the basic concepts behind the operation of nano scale MOSFET
- Describe the various techniques and approaches for the fabrication of nano-scale devices

Section A

The 'Top down' and 'Bottom up' approach, Nanotechnology potential, introductory quantum mechanics for Nanoscience: size effect in smaller systems, quantum behavior of nanometric world, Band structure and density of states at Nanoscale: energy bands, density of states at low dimensional structure. Semiconductor heterostructure quantum wells, quantum wires, and quantum dots.

Section B

MOS band structure, CMOS Scaling, The nanoscale MOSFET, Finfets, Vertical MOSFETs, limits to scaling, Tunnel junction and application of tunneling: Tunneling through a potential barrier, potential energy profiles of material interfaces, Classical and semi-classical transport, ballistic transport, carbon nanotubes, Single electron transistor, Coulomb Blockade, Resonant Tunneling diodes and transistors.

Section C

Buck minsterfullerence, Nanodiomond, Molecular Machine, Nanobiometrics. **Fabrication technology**: Top-down vs. bottom-up technology. **Lithographic process**: Lithography, Nanolithography, split gate technology, self-assembly, limitation of lithographic process. **Non-lithographic techniques:** Plasma arc discharge, sputtering, evaporation, chemical vapour deposition, pulsed laser deposition, molecular beam epitaxy, sol-gel technique, electro deposition and other process.

Recommended Books:

1. Hanson, G. W. (2008). *Fundamentals of Nanoelectronics*. New Delhi: Pearson Publication.
2. Chattopadhyay, K. K., & Banerjee, A. N. (2009). *Introduction to Nanoscience and Nanotechnology*. New Delhi: PHI Publication.
3. Mitin, Vlaadiniz.U. (2009). *Introduction to Nanoelectronics*. New Delhi: Cambridge University Press.
4. Dragman,M., &Dragman,D. (2008). *Nanoelectronics- Principles and Devices (2/e)*: Artech House Publishers
5. Goser, Karl. (2004). *Nanoelectronics and Nanosystems*. Berlin: Springer Publication
6. Minoli, Daniel. (2005). *Nanotechnology Application toTelecommunication and Networking*. Hoboken, New Jersey: Wiley Publication.
7. Davis ,John. H. (1997). *Physics of Low Dimension Semiconductor*. New Delhi: Cambridge University Press.
8. Cosh, Carl.C. (1998). Nanostructure Materials Processing Property and Applications. Norwich, New York: Noyes Publications

ECE 403 Mobile Communication

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- To understand the various generations of mobile communications and basics of wireless communication
- To understand the concept of cellular communication
- Can test mobile communication equipment for the technical functionality
- Knowledge of GSM mobile communication standard, its architecture, logical channels, advantages and limitations

Section A

Introduction to Wireless Communication System: Evolution of mobile radio communication, Mobile radiotelephony in U.S Mobile radio system around the world, second generation (2G) cellular network, evolution to 2 5G wireless network evolution for 2.5G TDMA standards, third generation (3G) wireless network. The Cellular concept- System design fundamentals, frequency reuse channel, assignment strategies. Hand off strategies Interference and system capacity, improving coverage and capacity in cellular system.

Section B

Propagation model and Spread Spectrum Modulation Techniques: Longley rice model, kumara model hata model pcs extension to hata model, wolfish and betony model, Pseudo Noise (PN) sequence,. Direct sequence spread spectrum (DSSS), frequency hopped spread spectrum (FHSS). Multiple Access Techniques for Wireless Communication, Introduction to multiple access. Frequency division multiple access (FDMA) Time division Multiple access (TDMA).

Section C

Spread spectrum multiple access. Packet Radio. Global System for Mobile Communication, channel types, Example of a GSM cell. Frame structure of GSM, Data over low power wireless Re-cordless Network.

Recommended Books:

1. Rappaport, Theodre. S. (2014) *Wireless Communication***.** New Delhi: Pearson Publication.
2. Pandya, Raj. (1999). *Mobile and Personal Communication System and Services***:** New Delhi: PHI Publication.
3. Goddman, David.J. (1997). *Wireless Personal Communication System***:**Addition Wesley Publication.
4. Tesal, Joachim. (1997). *GSM cellular Radio***:** New Delhi: John Wiley Publication

Suggested E-Resources:

1. **Wireless Communications** by Prof. Dr.Ranjan Bose, Department of Electrical Engineering, IIT Delhi.

   https://nptel.ac.in/courses/117102062/

ECE 405 Radar Navigation

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes: After successful completion of the course, student will be able to:

- Understand the basic concept of Radar and applications of various types.
- Understand the different Radar Performance factors.
- Explain the operation of CW& FM Radar.
- Understand the Satellite navigation system.

Section A

RADAR SIGNAL MODELS: Amplitude models, distributed target forms of range equation, radar cross section, statistical description of radar cross section, Swerling model, Clutter, signal to clutter ratio, temporal and spatial correlation of clutter, noise model and signal to noise ratio, frequency models, Doppler shift, simplifies approach to Doppler shift, stop and hop assumption, spatial model, variation with angle, variation with range, projections, multipath, spectral models.

RADAR WAVE FORMS: Waveform matched filter of moving targets, ambiguity function, ambiguity function of the simple matched pulse filter for the pulse burst, pulse by pulse processing, range ambiguity, Doppler response and ambiguity function of the pulse burst.

Section B

DETECTION FUNDAMENTALS: Radar detection as hypothesis testing, Neyman-Pearson detection rule, likelihood ratio test, threshold detection of radar signals, non-coherent integration of nonfluctuating targets, Albersheim and Shnidaman equations, Binary integration.

RADIO DIRECTION FINDING: loop direction finder, goniometer, errors in direction finding, adcock and automatic direction finders, commutated aerial direction finder. RADIO RANGES: LF/MF four course radio ranges, VOR, ground equipment & receiver, VOR errors.

HYBERBOLIC SYSTEM OF NAVIGATION: LORAN Decca & Omega system.DME & TECAN.

Section C

Aids to approach and landing: ILS, GCA & MLS

Doppler navigation: beam configuration, doppler frequency equation, track stabilisation and doppler spectrum, components of doppler navigation system, doppler radar equipment, CW & FMCW doppler radar, frequency trackers, doppler range equation.

Satallite navigation system: transit system, navstar, gps, basic principles of operation, signal structure of navstar broadcasts, data message, velocity determination, accuracy of GPS & differential navigation, navstar receiver.

Recommended Books:

1. Richards, Mark. A (2014). *Fundamentals of Radar Signal Processing*. New Delhi:TMH Publication.
2. Nagraja, N. S. (2009). *Elements of Electronics Navigation*: New Delhi:TMH Publication.
3. Peebles Jr. P. Z. (1998). *Radar Principles*. New Delhi: Wiley Publication.

Suggested E-Resources:

1. **Introduction to Radar Systems** by Dr. Robert O'Donnell, Massachusetts Institute of Technology.

   https://ocw.mit.edu/resources/res-ll-001-introduction-to-radar-systems-spring-2007

RS 401 Geoinformatics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Describe spatial database, Co-ordinate and projection system
- Analyse vector and raster based analysis in Geographical Information Sciences
- Describe global cover based global position systems i.e. GPS, GLONASS
- Describes applications of remote sensing and GIS in natural resources management

Section A

Geographical Information System: Definition, Components of GIS, Hardware and software requirements for GIS, Coordinate system and projections, Database structure and formats, Spatial data models - raster and vector. Data inputting, Data base design - editing and topology creation. Linkage between spatial and Non spatial data, Query (Attribute/Spatial), Vector based analysis. Raster based analysis. Errors, Digital Elevation Model, Network analysis, O'pen source and WebGIS.

Section B

Remote Sensing: Definition - components of remote sensing - energy sensor, interacting body; Type - active and passive remote sensing. Satellite System - meteorological, communication and remote sensing. Platforms - aerial and space, synoptivity and repeativity. Electromagnetic Radiation (EMR) - EMR spectrum- visible, infrared [IR) middle IR, thermal IR and microwave. EMR interaction with earth surface material, radiance, irradiance, incident, reflected, absorbed and transmitted energy, spectral response pattern - spectral signature curves (water, soil and vegetation].

Digital Image Processing : Digital Image, Satellite Image - characteristics and formats. Resolution - spatial, spectral, radiometric and temporal; Introduction to rectification, enhancement; Classification - Unsupervised and Supervised classification.

Section C

Global Positioning System: Global Navigation Satellite System (GNSS), GPS, GLONASS, GALILEO, Segments - space, control, user, GPS Satellite signals, sources of errors and corrections.

Applications of Remote Sensing and GIS:

Applications of GIS and Remote Sensing in resource management (forestry, agriculture, urban telecommunication, transportation, water resources and environment).

Recommended Books:

1. Chor, Pang. Lo.,&Albert, K. W. Yeung (2006). *Concepts and Techniques-of Geographic Information Systems*. New Delhi: PHI Publication.
2. Heywood, D.I., Cornelius, S. & Carver, S. (2009). *An Introduction to Geographical Information Systems*. New Delhi: Pearson Publication.

3. Joseph, G. (2005). *Fundamentals of remote sensing*. Jaipur, Rajasthan: Universities Press.
4. Jensen, John. R. (2015). *Introductory Digital Image Processing: A Remote Sensing Perspective*. New Delhi: Pearson Publication.
5. Sabins, Floyd F. (2007). *Remote Sensing: Principles and Interpretation*. Long Grove, Illinois: Waveland Press

Suggested e-resources:

1. **Geoinformatics** by University of Twente. https://www.itc.nl/ilwis/applications-guide/
2. **Geographical Information System** by Dr A. K. Gosain, Indian Institute of Technology, Delhi. https://nptel.ac.in/courses/105102015/1

ELE 402 Audio and Video Systems

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes: After successful completion of the course, student will be able to:

- Understand the fundamental concepts of television transmitter, receiver systems and the transmission of video signals and importance of television standards.
- Understand different colour television systems used worldwide and its compatibility.
- Understand principles of recording and reproduction of disc and video cassette recorders.

Section A

Audio Systems: Types of microphones and speakers, Monophonic, stereophonic and quadraphonic audio systems.

Disc and Magnetic Recording and Reproduction : Monophonic and stereophonic disc recording and reproducing systems, Magnetic recording , playback, Biasing & equalization, Recording medium, Magnetic heads-replay & eraser heads, Audio cassettes, Tape speed, Maximum usable

frequency, Tape transport mechanism, Distortion & noise aspects, Hi-Fi stereo system.

Section B

Video Cassette Recorders: Video recording requirements, Video tape formats. Modulation-up conversion and down conversion of video signal, Servo systems, Functional Block diagram of VCR: video recording & playback.

Compact Disc Recording and Reproduction: advantages of Compact disc, & its Specifications, CD player, optical recording, CD technology & manufacturing, CDROM, CD video.

Section C

Video Cameras: Image conversion principle, Plumbicon, Sidicon camera tubes, three tubes colored camera, Block diagram of color camera tube.

TV Engineering: Scanning process, Interlaced scanning, Composite video signals, Principle of black & white TV, color TV, Primary colours, Chrominance & luminance signals.

Recommended Books:

1. Bali, S.P.,&Bali, R. (2014). *Audio Video Systems Principles, Practices, and Troubleshooting***.** New Delhi: Khanna Book Publishing Co.
2. Sharma, Ajay. (1998). Audio *and Video Systems***.** New Delhi: Dhanpat Rai & Co.
3. Gupta, R.G. (2010). *Audio and Video Systems: Principles, Maintenance and Troubleshooting***.** New Delhi: Tata Mc-Graw Hill

Suggested e-resources:

1. **Digital Video Signal Processing** by Prof. Sumana Gupta, Department of Electrical Engineering, IIT Kanpur. https://nptel.ac.in/courses/117104020/1
2. **Audio System Engineering** by Prof. Shyamal Kumar Das Mandal, Department of Electronics and Communication Engineering, Indian Institute of Technology, Kharagpur. https://nptel.ac.in/courses/117105133/22

CS 401 Artificial Intelligence

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes:

After the completion of this course students will be able to –

- Describe the various searching techniques, constraint satisfaction problem and example problems- game playing techniques.
- Apply these techniques in applications which involve perception, reasoning and learning.
- Explain the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.
- Acquire the knowledge of real world Knowledge representation.
- Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.
- Use different machine learning techniques to design AI machine and enveloping applications for real world problems.

Section A

Introduction to Artificial Intelligence, General problem solving, state space and graph model techniques, Heuristic designs, Aim-oriented heuristic algorithms versus solution guaranteed algorithms, Game playing strategies.

Knowledge representation: Knowledge representation tools, First order predicate calculus. The language PROLOG - sementic nets, partitioned nets, Minsky's frames, case grammer theory, production rules, knowledge base, the inference system, forward and backward deduction.

Section B

Expert systems: Structure, development tools, uncertainty considerations, domain exploration, meta knowledge, expertize transfer, existing systems (DENDRAL, MYCIN), self explaining systems.

Planing: Planing Vs Seach, Problem Formulation, Planning as Search and Calculus, Stanford Research Institute Problem Solver (STRIPS), Representing States, Goals, Actions and Plans in STRIPS, Partial Order Planning, Dealing with Possible Threats.

Section C

Understanding Natural Language, Parsing techniques, context free and transformational grammer, transition net, augumented transition nets, Fillmore's grammer, Shanks conceptual dependency. Grammer free analysers, Sentence generation, Translation.

Introduction to Machine Learning, Patter Recognition as a Machine Learning Problem, Types of Pattern Recognition.

Suggested Readings:

1. Rich, E., & Knight, K. (1991). *Artificial intelligence*. Tata McGraw-Hill.
2. Russell, S., & Norvig, P. (2011). *Artificial Intelligence A Modern Approach*. 3rd Edition: Pearson Education.
3. Patterson, D. W. (1990). *Introduction to artificial intelligence and expert systems*. Prentice-hall of India.
4. Barr, A., Cohen, P. R., & Feigenbaum, E. A. (2014). *The handbook of artificial intelligence (Vol I, Vol II and Vol III).* Addison-Wesley Pub.
5. Allen, J. (1995). *Natural language understanding*. Pearson.
6. Nilsson, N. J. (2014). *Principles of artificial intelligence*. Morgan Kaufmann.
7. Jackson, P. (1998). *Introduction to expert systems*. Addison-Wesley Longman Publishing Co., Inc.
8. Charniak, E. (1985). *Introduction to artificial intelligence*. Pearson Education India.

Suggested E-Learning Materials

1. **Artificial Intelligence**

   https://nptel.ac.in/courses/106105077/

2. **Artificial Intelligence: Principles and Techniques**

   https://web.stanford.edu/class/cs221/

IT 412 Internet of Things

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

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

- Understand the concept of IoT
- Understand what constitutes an IoT design solution
- Identify the sensors and basic electronic design needed for different IoT solutions
- Analyze basic proptocols of IoT
- Implement basic IoT applications on Arduino and Raspberry Pi to provide IoT solutions for various domains.

Section A

Introduction of IoT, Sensing, Actuation, Sensor Networks, Machine-to-Machine Communications M2M to IoT –Introduction, industrial structure for IoT, architecture for conversion of M2M to IoT, design principles, capabilities of IoT, IoT network architecture, standard protocols, IoT Architecture Reference Model, Introduction to SDN, SDN for IoT, Data Handling and Analytics, Introduction to Cloud and Fog Computing, Sensor-Cloud. Domain specific applications of IoT: Home automation, Industrial applications, Surveillance applications, other IoT applications.

Section B

IoT Access Technologies: Physical and MAC layers, Bluetooth, RFID, WiMax, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing protocols (Routing over Low Power and Lossy Networks) Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP and MQTT, Security in IoT protocols.

Section C

Introduction to concept of IoT devices, IoT configurations, basic components, networking, sensors, introduction to Edge computing and Embedded IoT.

Introduction to Arduino, types of Arduino, Arduino toolchain, Arduino programming structure, Sketches, Pins, Input-output from pins using sketches, Introduction to Arduino shields, Introduction to Raspberry-Pi microcomputer Accessing GPIO pins, Sending and receiving signals using GPIO pins

Suggested Books:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos,
2. David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
3. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014.
4. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013

Suggested E-Resources:

1. https://onlinecourses.nptel.ac.in/noc19_cs31
2. https://www.edx.org/course/introduction-to-the-internet-of-things-iot-1
3. https://www.edx.org/course/sensors-and-devices-in-the-iot
4. https://www.edx.org/course/iot-networks-and-protocols
5. https://alison.com/course/internet-of-things-and-the-cloud
6. https://online.stanford.edu/courses/xee100-introduction-internet-things

CS 450 Machine Learning

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course students will be able to

- Describe the various searching techniques, constraint satisfaction problem and example problems- game playing techniques.
- Apply these techniques in applications which involve perception, reasoning and learning.
- Explain the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.
- Acquire the knowledge of real world Knowledge representation.
- Analyze and design a real world problem for implementation and understand the dynamic behavior of a system.
- Use different machine learning techniques to design AI machine and enveloping applications for real world problems.

Section A

Introduction to Machine Learning, Types of Machine Learning, Data Preprocessing, Importance of features in learning, Feature Selection, Feature Extraction Process, Knowledge Representation, Applications of Machine Learning Algorithms

Section B

Types of Supervised Learning, Difference between Classification and Regression, Understanding Regression: Simple, Multiple and Polynomial, Exploring popular learning algorithms for regression and classification: Support Vector Machine (Regression and Classification), Decision Tree (Regression and Classification), Naïve Bayes (Classification), Evaluation of Classification and Regression Models

Section C

Introduction to Clustering, K-Means, Hierarchical, Introduction to Reinforcement Learning, Upper Confidence Bound, Thompson Sampling.

Model Selection and Boosting, k-fold Cross Validation, XGBoost.

Natural Language Processing, Extraction of features from Text, Tokenization, Understanding Markovian Process for Text Processing. Case Studies.

Suggested Books:

1. Mitchell T.M. (1997). *Machine Learnin.*, McGraw Hill International
2. Flach, P. (2012). *Machine learning: the art and science of algorithms that make sense of data*. Cambridge University Press.
3. Mohri, M., Rostamizadeh, A., & Talwalkar, A. (2018). *Foundations of machine learning*. MIT press.
4. Murphy, K. P. (2012). *Machine learning: a probabilistic perspective*. MIT press.

Suggested E-Learning Material:

1. **IBM's Cognitive AI Class**
   https://cognitiveclass.ai
2. **MIT's Open Courseware on Machine Learning**
   https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-867-machine-learning-fall-2006/
3. **Scikit Learn Online Documentation**
   https://scikitlearn.org/stable/documentation.html

CS 441 Computer Vision

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course students will be able to

- Identify basic concepts, terminology, theories, models and methods in the field of computer vision.
- Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition.
- Assess which methods to use for solving a given problem, and analyze the accuracy of the methods.

Section A

Introduction: Motivation, Introduction to Computer Vision and Image Analysis, Human Eye, Camera model, CCD camera, Human colour perception, Colour models.

Segmentation: Threshold based segmentation, Edge based segmentation, Border detection, Hough transform, Region based segmentation, Watershed segmentation, Evaluation issues in segmentation, Mean shift segmentation, Active contour models, Level sets and Geodesic active contours, Optimal single and multiple surface segmentation.

Section B

Shape Representation and Description: Region identification, Contour based shape representation and description, Boundary description, B-splines, Shape invariants, Moments, Shape classes.

Object Recognition: Classification principles, SVM, Neural nets, Syntactic pattern recognition,

Image Understanding: Image understanding control strategies, Hierarchical control, Bottom-up control, Model-based control, Classification based segmentation, Contextual image classification, Scene labelling, Semantic image segmentation, Hidden Markov models, Bayesian belief network.

Section C

3D Vision: Marr's theory, Active and Purposive vision, A single perspective camera, Camera Calibration from a known scene, Scene reconstruction from multiple views, Two camera, Stereopsis, Relative motion of the camera, Fundamental matrix, Stereo correspondence algorithms, Photometric stereo, Shape from motion, Shape from texture, 3D model based vision, Multi view representation.

Tracking: Object tracking, Motion models, Kalman Filtering, Feature fusion in a Particle filter, Multi target tracking.

Applications: Intelligent video surveillance, Mobile robots, Medical imaging, Human object identification, digital libraries, image based rendering, Deep Learning for Computer Vision

Suggested Books:

1. Sonka, M., Hlavac, V., & Boyle, R. (2014). *Image processing, analysis, and machine vision*. Cengage Learning.
2. Szeliski, R. (2010). *Computer vision: algorithms and applications*. Springer Science & Business Media.

3. Forsyth David, A., & Jean, P. (2002). *Computer Vision: a modern approach*. PHI.
4. Cipolla, R., Battiato, S., & Farinella, G. M. (Eds.). (2010). *Computer Vision: Detection, recognition and reconstruction* (Vol. 285). Springer.

Suggested E-Learning Material:

1. **Computer Vision: Foundations and Applications**
   http://vision.stanford.edu/teaching/cs131_fall1415/schedule.html
2. **Deep Learning in Computer Vision**
   https://www.coursera.org/learn/deep-learning-in-computer-vision

CS 433 Soft Computing

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

On successful completion of the course students will be able to:

- Understand the concepts of Neural Networks and its applications.
- Learn supervised and unsupervised neural network models.
- Use the concepts of Fuzzy logic and Fuzzy sets for implementation of real life problems.
- Apply the concepts of evolutionary computations on different problems.
- Able to design hybrid intelligent systems using soft computing techniques.

Section A

Introduction to Soft Computing, Neural Networks: Introduction and Applications, Biological and Artificial Neural Network, Types of Neural Network Architectures, McCulloch-Pitts Neuron, Learning in Neural Networks – Supervised, Unsupervised and Reinforcement, Hebbian, Competitive and Delta Learning, Perceptron, Multilayer Perceptron, Backpropagation, Radial Basis Functions, Self Organizing Maps, Learning Vector Quantization, Recurrent Neural Networks, Hopfield Networks, Boltzmann Machine.

Section B

Introduction to Fuzzy Logic and Fuzzy Sets: Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions, Fuzzification, Defuzzification, Fuzzy Rule based Systems and Linguistic Variables, Fuzzy Extension

Principle, Fuzzy Inference Systems (FIS)- Mamdani, Sugeno and Tsukamoto, Applications of Fuzzy logic.

Section C

Evolutionary Computing: Introduction, Variants of Evolutionary Computing-Genetic Algorithms (GA), Evolutionary Programming, Learning Classifier Systems, Genetic Programming. Foundations of Genetic Algorithms-Basic Terminologies, Operators in GA. Schema Theorem, Hybrid Systems (Neuro-Fuzzy, Genetic-Neuro, Fuzzy-Genetic) .

Suggested Books:

1. Haykin, S. (2009). *Neural networks: a comprehensive foundation*. Prentice Hall PTR.
2. Goldberg, D. E. (2007). *Genetic algorithms in search optimization and machine learning*. Pearson.
3. Zimmermann, H. J. (1996). *Fuzzy set theory and applications*. Allied Publishers,1996.
4. Rajasekaran, S., & Pai, G. V. (2003). *Neural networks, fuzzy logic and genetic algorithm: synthesis and applications*. PHI Learning Pvt. Ltd.
5. Ross, T. J. (2005). *Fuzzy logic with engineering applications.* John Wiley & Sons.
6. Eiben, A. E., & Smith, J. E. (2003). *Introduction to evolutionary computing*. Springer.
7. Sivanandam, S. N., & Deepa, S. N. (2007). *Principles of Soft Computing*. John Wiley & Sons.

Suggested E-Resources:

1. **Neuro-Fuzzy and Soft Computing**
   http://www.cs.nthu.edu.tw/~jang/nfsc.htm
2. **Introduction to Soft Computing**
   https://nptel.ac.in/courses/106105173/
3. **Neural Networks and Deep Learning**
   https://www.coursera.org/courses?query=neural%20networks

Reading Electives

ELE 413R Electronic Packaging

Max. Marks : 100	**L**	**T**	**P**	**C**
ESA : 100	**0**	**0**	**4**	**2**

This course is designed to provide a basic knowledge of the technologies and processes required for the packaging of electronic products. The focus of the course will be on the mechanical, and materials aspects which are often neglected in the design phase with potentially catastrophic consequences. Students will be expected to explore the underlying scientific and technological knowledge-based needed to become proficient builders and users of electronic systems. The students will also be able to explain the fundamental principles for packaging active and passive electronic devices; design of components, circuit boards, connectors, and assemblies; electromagnetic interference and its impact on packaging, thermal and mechanical design; and reliability assessment methods**.**

Suggested e-resource:

1. **Electronics Packaging and Manufacturing** by IIT Kharagpur https://onlinecourses.nptel.ac.in/noc18_me54.

ELE 416R Multimedia Compression and Communication

Max. Marks : 100	**L**	**T**	**P**	**C**
ESA : 100	**0**	**0**	**4**	**2**

The purpose of this course is to understand the multimedia communication and compression. In this course students will be expected to explore various multimedia components and their characteristics, such as hardware, animation and graphics and able to explain the various audio and video compression techniques and apply these techniques in multimedia communication. The student will also be able to develop the understanding of network architecture, protocols, resource management, multimedia operating systems, scheduling and policing mechanisms.

Suggested e-resource:

1. **Multimedia Processing** by IIT Kharagpur. https://nptel.ac.in/syllabus/117105083/.

ELE 417R Professional Ethics

Max. Marks : 100	L	T	P	C
ESA : 100	0	0	4	2

The course is intended to provide participants with the ability to analyze ethical situations, such as how they interact and what can be expected from them as correct ethical behaviour. In turn, any professional will benefit from a critical scrutiny of their own ethics by those from other professions. The general principles of professional ethics will be examined, as well as the distinctive problems of the different fields. The participant will also be expected to explain the pertaining issues, such as professional codes of ethics, confidentiality, obligations and Moral Values in Professional Ethics, the limits of predictability and responsibilities of the engineering profession, research misconduct, and work place rights & responsibilities.

Suggested e-resources:

1. **Professional Ethics** by Rochester Institute of Technology. http://www.openculture.com/professional-ethics-a-free-online-course.
2. **Ethical Practice: Leading Through Professionalism, Social Responsibility, and System Design** by Prof. Leigh Hafrey, MIT, USA. https://ocw.mit.edu/courses/sloan-school-of-management/15-270-ethical-practice-leading-through-professionalism-social-responsibility-and-system-design-spring-2016.

ELE 418R Telecommunication Switching Systems and Networks

Max. Marks : 100	L	T	P	C
ESA : 100	0	0	4	2

The course is intended to develop the good understanding of the fundamentals and application of telecommunication networks i.e. PSTN, PDN and ISDN, modern digital telecommunication switching and networks. The participants will be expected to explain the recent terminology, like switching systems, traffic management, time division switching systems, data communication Networks, routing, ISDN, voice

data integration and importance of telephone traffic analysis and telephone networks.

Suggested e-resources:

1. **Computer Networks** by Department of CSE, IIT Kharagpur https://nptel.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Communication%20network/New_index1.html
2. **Data Communication** by IIT Kharagpur. https://nptel.ac.in/courses/106105082/19.

Onilne Reading Electives
Electric Vehicles

Electric vehicles are the future of transportation. Electric mobility has become an essential part of the energy transition, and will imply significant changes for vehicle manufacturers, governments, companies and individuals. This course prepare the students for product development positions in the automotive, communications, solar, wind turbine, and smart grid industries and service positions in the automotive industry. This course will be a first level course on electric vehicle. Students will be able to understand the operation of battery driven electric vehicle. The course will focus on areas that come under the umbrella of electric vehicles, such as vehicle dynamics, Motors, Power Electronics, Batteries, Charging and etc. Students will explore the most important aspects of this new market, including state-of-the-art technology of electric vehicles and charging infrastructure.

Suggested e-resources:

1. **Electric Vehicles Part 1** by IIT Delhi. https://onlinecourses.nptel.ac.in/noc19_ee18/preview.
2. **Electric Cars: Introduction** by Delft University of Technology (TU Delft). https://www.edx.org/course/electric-cars-introduction-0.

IoT Sensors and Devices

This course is for practical learners who want to explore and interact with the IoT Bridge between the cyber- and physical world. Student will learn about the 'things' that get connected in the Internet of Things to sense and interact with the real world environment – from something as simple as a smoke detector to a robotic arm in manufacturing. This course is about the devices that feel and the devices that respond. The course also describe about IoT sensors, actuators and intermediary devices that connect things to the internet, as well as electronics and systems, both of which underpin how the Internet of Things works and what it is designed to do.

Suggested e-resources:

1. **IoT Sensors and Devices** by Curtin University. https://www.edx.org/course/sensors-and-devices-in-the-iot.
2. **Internet of Things: Sensing and Actuation** by University of California San Diego https://www.coursera.org/learn/internet-of-things-sensing-actuation.

Electromagnetic Compatibility

This course describe the systems that generate or consume electrical energy can produce electromagnetic noise that may interfere with the operation of the system itself and/or other systems. The course will enable students to understand how the principles of electricity and magnetism can be applied to design electrical and electronic systems that can co-exist harmoniously, that is, to design systems that are electromagnetically compatible with each other. The students will also be expected to explain how electromagnetic disturbances are generated in systems, how they couple to other systems, and how systems can be protected.

Suggested e-resource:

1. **Electromagnetic Compatibility** by Daniel Mansson, KTH Royal Institute of Technology, Sweden

   https://onlinecourses.nptel.ac.in/noc19_ee17/preview.

Reading Electives and Their Source Institution:

S.No.	Course	Branch	Institute	Period	Links
1	Fundamental of Semiconductor Devices	EE/EI/ MT	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-bt17/
2	Principles of Signals and Systems	EE/EI/ MT	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee15/
3	Advance power electronics and Control	EE	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee28/
4	Environmental Quality Monitoring & Analysis	EE/EI	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ch01/
5	Advance Power Electronics and Control	EE	NPTEL	8 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee28/
6	Electromagnetic Compatibility	EE	NPTEL	8 Weeks	
7	Antennas	EE/EI	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee20/
8	Introduction to Photonics	EE/EI	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee23/
9	Transmission lines and electromagnetic waves	EE/EI	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee04/
10	Biomedical signal processing	EE/EI	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee41/
11	Embedded System Design With ARM	EE/EI/ MT	NPTEL	8 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs15/
12	Introduction To Industry 4.0 And Industrial Internet Of Things	EE/EI/ MT	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs24/
13	Mathematical methods and techniques in signal processing	EE/EI/ MT	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee51/
14	Analog IC Design	EE/EI/ MT	NPTEL	12 weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ee26/

15	Industrial Automation and Control	EE	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-me39/
16	Non-Conventional Energy Resources	EE	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ge06/
17	Deep Learning		NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs11/
18	Quality Design And Control	EI/EE/ MT	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mg18/
19	Interfacing with Arduino	EI/MT/ EE	Coursera	4 weeks	https://www.coursera.org/learn/interface-with-arduino
20	Building Arduino robots and devices	EI/EE/ MT	Coursera	4 weeks	https://www.coursera.org/learn/arduino
21	Introduction to Python for Data Science	EI/EE/ MT	Edx	6 weeks	https://www.edx.org/course/introduction-to-python-for-data-science-2
22	Industry 4.0	EE	Edx	6 weeks	https://www.edx.org/course/industry-40-how-to-revolutionize-your-business
23	Metal Cutting And Machine Tools	MT	Swayam	4 weeks	https://swayam.gov.in/nd1_noc20_me16/preview
24	Solar Photovoltaics : Principles, Technologies & Materials	EE/EI/ MT	NPTEL	8 weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm05/
25	Introduction to Internet of Things	MT/EE /EI	NPTEL	12 Weeks	https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-cs22/
26	Introduction to Machine Learning	EI/EE/ MT	Swayam	8 weeks	https://swayam.gov.in/nd1_noc19_cs52/preview
27	Python for Data Science	EI/EE/ MT	Swayam	4 weeks	https://swayam.gov.in/nd1_noc20_cs36/preview
28	An Introduction to Artificial Intelligence	EI/EE/ MT	Swayam	12 weeks	https://swayam.gov.in/nd1_noc20_cs42/preview