PROGRESSIVE EDUCATION SOCIETY'S

# MODERN COLLEGE OF ENGINEERING

1186A, SHIVAJINAGAR, OFF J.M, PUNE-411005

**(AFFILIATED TO SAVITRIBAI PHULE PUNE UNIVERSIT, PUNE)**

## DEPARTMENT OF ELECTRICAL ENGINEERING

# E-CURRICULUM BOOKLET

**(2019 Course)**

**FOR THE PROGRAMME**

## SE – ELECTRICAL ENGINEERING

**(SEMISTER-II)**

## QUALITY POLICY OF THE INSTITUTE

**We, PES Modern College of Engineering are committed to develop and foster cultured and promising professionals by imparting quality education in the field of Engineering and Management.**

## VISION OF THE INSTITUTION

**To create a collaborative academic environment to foster professional excellence and ethical values**

## MISSION OF THE INSTITUTE

1. **To develop ethical standards capable of creating and managing global enterprises.**
2. **To foster innovation and research by providing a stimulating learning environment.**
3. **To ensure equitable development of students of all ability levels and backgrounds.**
4. **To be responsive to changes in technology, socio-economic levels and environmental conditions.**
5. **To foster and maintain mutually beneficial partnerships with alumni and industry.**

## QUALITY POLICY OF THE DEPARTMENT

**Electrical Engineering department is committed to develop promising engineers with ethical and social responsibility through excellence in academics, research, skill development and consultancy.**

## VISION OF THE DEPARTMENT

**To build technically competent Electrical Engineers with ethical and social responsibility.**

## MISSION OF THE DEPARTMENT

- **To develop abilities in students for acquiring knowledge and skills to flourish in dynamic technical environment.**
- **To nurture cultured professionals by providing facilities for their overall development.**
- **To motivate the students for research work and activities beneficial to society.**
- **To enhance strong bonding with various organization and alumni.**

## Program Educational Objectives (PEOs)

**Graduates will be able to:**

**PEO 1:** Solve and analyze problems in Electrical Engineering using fundamental knowledge.

**PEO 2:** Adopt lifelong learning ability by acquiring various skills.

**PEO 3:** Practice ethically in their profession.

**PEO 4:** Achieve global competency through interactions with various industries, research and professional organizations.

## PROGRAM OUTCOMES (POs)

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

**PO2. Prolem analysis:** Identify, formulate, research literature, and analyses complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3. 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.

**PO4. Conduct investigations of complex problems:** The problems that cannot be solved by straight forward application of knowledge, theories and technique applicable tothe engineering discipline that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions that require consideration of appropriate constraints/requirements not explicitly given in the problem statement. (Like: cost, power requirement, durability, product life, etc.). Which need to be defined (modeled) within appropriate mathematical framework that often requires use of modern computational concepts and tools.

**PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6. 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.

**PO7. 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.

**PO8. Ethics:** Apply ethical principles and commit to professional ethics and 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 settings.

**PO10. 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.

**PO11. 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.

**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.

## PROGRAM SPECIFIC OUTCOMES:

**PSO1:** Students will be able to apply logical and technical concepts of automation, control syste and electric mobility.

**PSO2:** Students will be able to develop adequate competency in electrical energy manageme through conventional and non-conventional energy sources.

## CORE VALUES

- Excellence in the field of Electrical Engineering.
- Social responsibility with integrity.
- Lifelong Learning.
- Unity in Diversity.

## SHORT TERM GOALS

- To enhance alumni interaction.
- To develop innovation lab to enhance research and entrepreneurship by providing various facilities.

## LONG TERM GOALS

- To promote consultancy activity for revenue generation by developing high-tech standard laboratory.
- To encourage the faculty for research work and up gradation of qualifications.
- To enhance teaching-learning process through ICT.
- To establish competitive entrance exam cell in department.

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# Course Structure

*Savitribai Phule Pune University*

## Savitribai Phule Pune University

### Syllabus: Second Year (SE) Electrical Engineering (2019 Course) w.e.f. AY:2020-2021

**SEMESTER-I**

| Course Code | Courses Name | Teaching Scheme | | | Examination Scheme and Marks | | | | | | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TH | PR | TUT | ISE | ESE | TW | PR | OR | Total | TH | PR | TUT | Total |
| 207006 | Engineering Mathematics-III | 03 | – | -- | 30 | 70 | -- | – | – | 100 | 03 | -- | – | 03 |
| 203141 | Power Generation Technologies | 03 | – | -- | 30 | 70 | -- | – | – | 100 | 03 | -- | – | 03 |
| 203142 | Material Science | 03 | 04# | -- | 30 | 70 | 25 | – | 25 | 150 | 03 | 02 | – | 05 |
| 203143 | Analog and Digital Electronics | 03 | 02 | -- | 30 | 70 | -- | 50 | – | 150 | 03 | 01 | – | 04 |
| 203144 | Electrical Measurement & Instrumentation | 03 | 04# | -- | 30 | 70 | 25 | 25 | – | 150 | 03 | 02 | – | 05 |
| 203150 | Applications of Mathematics in Electrical Engineering | – | 02* | -- | -- | -- | 25 | – | – | 25 | -- | 01 | – | 01 |
| 203151 | Soft Skill | – | 02 | -- | -- | -- | 25 | – | – | 25 | -- | 01 | – | 01 |
| 203152 | Audit Course-III | – | – | -- | -- | -- | -- | – | – | – | Grade: PP/NP | | | |
| | Total | 15 | 14 | – | 150 | 350 | 100 | 75 | 25 | 700 | 15 | 07 | – | 22 |

**SEMESTER-II**

| Course Code | Courses Name | Teaching Scheme | | | Examination Scheme and Marks | | | | | | Credits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | TH | PR | TUT | ISE | ESE | TW | PR | OR | Total | TH | PR | TUT | Total |
| 203145 | Power System-I | 03 | – | -- | 30 | 70 | -- | – | – | 100 | 03 | -- | – | 03 |
| 203146 | Electrical Machines-I | 03 | 02 | -- | 30 | 70 | -- | 50 | – | 150 | 03 | 01 | – | 04 |
| 203147 | Network Analysis | 03 | 02 | -- | 30 | 70 | 25 | – | – | 125 | 03 | 01 | – | 04 |
| 203148 | Numerical Methods & Computer Programming | 03 | 02 | -- | 30 | 70 | -- | 25 | – | 125 | 03 | 01 | – | 04 |
| 203149 | Fundamental of Microcontroller and Applications | 03 | 04$ | -- | 30 | 70 | 25 | – | 25 | 150 | 03 | 02 | – | 05 |
| 203152 | Project Based Learning | – | 04 | -- | -- | -- | 50 | – | – | – | -- | 02 | – | – |
| 203153 | Audit Course-IV | – | – | -- | -- | -- | -- | – | – | – | Grade: PP/NP | | | |
| | Total | 15 | 14 | – | 150 | 350 | 100 | 75 | 25 | 700 | 15 | 07 | – | 22 |

* - Lab sessions on application of Mathematics in Electrical Engineering using professional software.
# - Practical section will comprises of two Part : a) PART A : 2 hours per week : Regular curriculum listed practical total 12 numbers out of which conduction of 8 numbers will be mandatory b) PART B : 2 Hours a week :Practical/case studies/assignments to enable active learning based on advances related to subject to bridge gap between curriculum and enhance practical knowledge required in field .
$ - Practical section will comprises of two Part : a) PART A : 2 hours per week : Regular curriculum listed practical total 12 numbers out of which conduction of 8 numbers will be mandatory b) PART B : 2 Hours a week : IOT application in Electrical Engineering using microcontroller and GSM module to bridge gap between curriculum and enhance application knowledge.
**Abbreviation**: TH: Theory, PR: Practical, TUT:Tutorial, ISE: Insem Exam, ESE: End Sem Exam, TW: Term Work, OR: Oral

# Power System-I
# (203145)

**Name of the Subject – Power System I**

| Weekly Work Load(in Hrs) | Lecture | Tutorial | Practical |
|---|---|---|---|
| | 03 | - | - |

| Online/ In-sem | Theory | Practical | Oral | Term-work | Total Marks | Credit |
|---|---|---|---|---|---|---|
| 30 | 70 | - | - | - | 100 | 03 |

**Unit 01: Structure of Electrical Power Systems and tariff: (6 Hrs)**

A) **Structure of Electrical Power Systems**: Structure of Electrical Power System, Different factors associated with generating stations such as Connected load, Maximum Demand, Demand Factor, average load, load factor, diversity factor, plant capacity factor, reserve capacity, plant use factor, Load curve, load duration curve, concept of base load and peak load stations, Interconnected grid system. Fitting of available generating stations into the area load duration curve.

B) **Tariff** : Introduction of Tariff, Tariff setting principles, desirable characteristics of Tariff, various consumer categories and implemented tariff such as two part, three part, Time of Day tariff for H.T. & L.T. industrial and commercial consumers along with current electricity charges, Introduction to Availability Based Tariff (ABT), Interruptible tariff, Incentives and penalties applied to various consumers.

**Unit 02: Major Electrical Equipment's in Power Stations and Overhead line Insulators : (6 Hrs)**

A) **Major Electrical Equipment's in Power Stations** : Descriptive treatment of ratings of various equipment used in power station, Special features, field of use of equipment like alternators, necessity of exciters, various excitation systems such as dc excitation, ac excitation and static excitation systems, transformers, voltage regulators, bus-bars, current limiting reactors, circuit breakers, protective relays, current transformers, Potential transformers, Lightning arresters, Earthingswitches, isolators, carrier current equipment (P.L.C.C.), Control panels, battery rooms, metering and other control room equipment in generating station course))

**B) Overhead Line Insulators**: Types of insulators & their applications such as pin type, suspension type, strain type, Silicon Rubber insulators, post insulators, Shackle insulators,

bushings, voltage distribution along string of suspension insulators, string efficiency, equalization of potential across each unit, method of improving string efficiency, Insulator failure.

**Unit 03 : Mechanical Design of Overhead Lines and Underground Cables: (6 Hrs)**

**A) Mechanical Design of Overhead Lines**: Main components of overhead lines, Line supports, conductor spacing, length of span, calculation of sag for equal and unequal supports and effect of ice and wind loadings.

**B) Underground Cables**: Classification, Construction of cable, XLPE cables, insulation resistance, dielectric stress in single core cable, capacitance of single core and three core cable, cables used for HVDC transmission. Grading of cables, inter sheath

**Unit 04 : Resistance and Inductance of Transmission Line: (6 Hrs)**

Resistance of transmission line, skin effect and its effects, proximity effect, internal & external flux linkages of single conductor, inductance of single phase two wire line, inductance of three phase line with symmetrical and unsymmetrical spacing, concept of G.M.R. and G.M.D, necessity of transposition, inductance of three phase double circuit line with symmetrical and unsymmetrical spacing, inductance of bundled conductors.

**Unit 05 : Capacitance of Transmission Line: (6 Hrs)**

Electric potential at single charged conductor, potential at conductor in a group of charged conductors, capacitance of single phase line, Capacitance of single phase line with effect of earth's surface on electric field, Concept of G.M.R. and G.M.D for capacitance calculations, capacitance of three phase line with symmetrical and unsymmetrical spacing, capacitance of double circuit three phase line with symmetrical and unsymmetrical space

**Unit 06 : Performance of Transmission Lines: (6 Hrs.)**

Classification of lines based on length and voltage levels such as short, medium and long lines. Performance of short transmission line with voltage current relationship and phasor diagram, Representation of medium lines as 'Nominal Pi' and 'Nominal Tee' circuits using R, L and C parameters. Ferranti effect, Representation of 'Tee' and 'Pi' models of lines as two port networks, evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, Estimation of Efficiency & regulation of short & medium lines.

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**Course Objectives**

- To learn the basic structure of electrical power systems, various electrical terms related with power system and understand various types of tariff
- To understand the specifications and applications of various major electrical equipment present in power plant.
- To get the knowledge of mechanical and electrical design of overhead and underground transmission system
- To learn representation of transmission lines for performance evaluation.

**Course Outcomes**

After successfully completing the course students will be able to:

1. Students will be able to summarize different patterns of load curve and calculate associated different factors with it and tariff.
2. Students will be able to summarize different patterns of load curve and calculate associated different factors with it and tariff.
3. Students will be able to summarize different patterns of load curve and calculate associated different factors with it and tariff.
4. Students will be able to evaluate the inductance and capacitance of different transmission line configurations
5. Students will be able to analyze the performance of short and medium transmission lines

## Academic Activity Planner

| Units | Unit Test1 (10marks) | Unit Test2 (10marks) | Assignment No:1 (10marks) | Assignment No:2 (10marks) | OBT : (10marks) | MCQ (10marks) |
|---|---|---|---|---|---|---|
| 1 | ✓ | | | | | |
| 2 | | ✓ | | | | |
| 3 | | | ✓ | | | |
| 4 | | | | ✓ | | |
| 5 | | | | | ✓ | |
| 6 | | | | | | ✓ |

PROGRESSIVE EDUCATION SOCIETY'S

# MODERN COLLEGE OF ENGINEERING

## DEPARTMENT OF ELECTRICAL ENGINEERING

**Teaching Plan**

**Teaching plan as per University Syllabus**

| Sr.No. | Unit | Broad Topics to be Covered | Total Lecture Planned |
|---|---|---|---|
| 1 | I | Structure of Electrical Power Systems:<br>A] Structure of electrical power system<br>B] Tariff | 08 |
| 2 | II | A]Major Electrical Equipment's in Power Stations<br>B] Underground Cables | 09 |
| 3 | III | A]Mechanical Design of Overhead Lines<br>B] Overhead Line Insulators | 08 |
| 4 | IV | Resistance & Inductance of transmission line | 09 |
| 5 | V | Capacitance of transmission line | 08 |
| 6 | VI | Performance of transmission line | 08 |

**Unit wise Lecture Plan**

**Unit No.-I: Structure of Electrical Power Systems:**

**A] Structure of electrical power system**

**B] Tariff**

## Pre-requisites:-

- Basic concepts of Power generation

**Objective:-**

- To learn basic structure of electrical power systems, various electrical terms related with power system
- To understand various types of tariffs.

**Outcome:**

- Recognize different patterns of load curve, calculate different factors associated with it
- Tariff structure for LT and HT consumers

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | General Introduction about Subject ,and its importance | T4,T3 and R1 | BB |
| 2 | Structure of Electrical Power System, Different factors associated with generating stations such as Connected load, Maximum Demand, Demand Factor | T4,T3 and R1 | BB,PPT |
| 3 | Average load, load factor, diversity factor, plant capacity factor, reserve capacity, plant use factor | T4,T3 and R1 | BB |
| 4 | Load curve & Numerical | T4,T3 and R1 | BB |

| | | | |
|---|---|---|---|
| 5 | Load duration curve, concept of base load and peak load stations, Interconnected grid system. Fitting of available generating stations into the area load duration curve. B | T4,T3 and R1 | BB,PPT |
| 6 | Introduction of Tariff, Tariff setting principles, desirable characteristics of Tariff, | T4,T3 and R1 | BB |
| 7 | Various consumer categories and implemented tariff such as two part, three part, Time of Day tariff for H.T. & L.T. industrial and commercial consumers along with current electricity charges | T4,T3 and R1 | BB |
| 8 | Introduction to Availability Based Tariff (ABT), Interruptible tariff, Incentives and penalties applied to various consumers. | T4,T3 and R1 | BB,PPT |

**Question Bank: Theory**

1. Explain how the load duration curve can be plotted from the load characteristics What information can be obtained from load duration curve?
2. Explain in brief various incentives and penalties offered by MSPDCL.to various types of consumer.
3. Explain base load plant and peak load plant in brief.
4. What is the essential requirement of good tariff?
5. Write short note on HT/ LT consumer line.
6. Define the term
   A) Maximum Demand
   B) Diversity factor
   C) Load factor
   D) Plant capacity factor
   E) Average demand
   F) Plant use factor

**Unit No.-II:**
**A]Major Electrical Equipment's in Power Stations**
**B] Underground Cables**

**Pre-requisites:-**

- Knowledge about electrical Equipment's like transformer, CT, PT, insulators

**Objectives:-**

- To learn different electrical equipment's used in power systems and Underground Cables

**Outcomes:-** After successfully completing this unit students will be able:

- Give Descriptive treatment of ratings of various equipment used in power station, underground cables used in power system overhead lines

| Lecture No. | Details of the Topic to be covered | References | Mode of delivery |
|---|---|---|---|
| 1 | Major Electrical Equipment's in Power Stations : Descriptive treatment of ratings of various equipment used in power station | T1,T2 and R1 | Chalk and talk ,PPT |
| 2 | Special features, field of use of equipment like alternators, necessity of exciters, various excitation systems such as dc excitation, ac excitation and static excitation systems | T1,T2 and R1 | Chalk and talk ,PPT |
| 3 | Transformers, voltage regulators, bus-bars, current limiting reactors, circuit breakers, protective relays, current transformers, Potential transformers, Lightning arresters, Earthing switches, isolators, carrier current equipment (P.L.C.C.), | T1,T2 and R1 | Chalk and talk and PPT |
| 4 | Control panels, battery rooms, metering and other control room equipment in generating stations. | T1,T2 and R1 | PPT |
| 5 | Underground Cables: Classification, Construction of cable, XLPE cables | T1,T2 and R1 | PPT |
| 6 | Capacitance of single core and three core | T1,T2 and R1 | PPT |

| | | | |
|---|---|---|---|
| | cable, cables used for HVDC transmission. | | |
| **7** | Grading of cables, inter sheath grading, capacitance grading. | T1,T2 and R1 | Chalk and talk |
| **8** | Numerical | ***T1,T2*** | Chalk and talk |

**Question Bank: Theory**

1. Explain with neat diagram typical generation transmission layout
2. Explain in brief necessity working of major equipments like circuit breakers isolators,bus bar reactor and control panels.
3. Derive the expression for capacitance of a 3 core cable system
4. Write a short note on XLPE cable
5. Explain in details the classification of cables.
6. Draw the cross sectional view of single core cable and explain the construction.
7. The concentric cable has core diameter 0.8 cm.,shath diameter 3.2 cm.If the cable is tested with 33 KV voltage calculate maximum and minimum stress.
8. What is the grading of cables? Explain any one method.

**Unit No.-III: A] Mechanical Design of Overhead Lines**

**B] Overhead Line Insulators**

## Pre-requisites:-

- Knowledge about resistance, inductance, capacitance and impedance.

**Objectives:-**

- To learn different method of overhead lines, various types of line supports, Conductor and overhead lines insulator

**Outcomes: -** After successfully completing this unit students will be able to:

- Designing of overhead lines, various types of Conductor supports in transmission line and insulators used for transmission line.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Mechanical Design of Overhead Lines :Main components of overhead lines, Line supports, | T1,T2 and R1 | Chalk and talk ,PPT |
| 2 | conductor spacing, length of span, calculation of sag for equal | T1,T2 and R1 | Chalk and talk ,PPT |
| 3 | Unequal supports and effect of ice and wind loadings. | T1,T2 and R1 | Chalk and talk |
| 4 | Numerical's on effects of ice and wind loadings | T1,T2 and R1 | PPT |
| 5 | **Overhead Line Insulators:** Types of insulators & their applications such as pin type | T1,T2 and R1 | PPT |
| 6 | suspension type, strain type, Silicon Rubber insulators, post insulators, Shackle insulators | T1,T2 and R1 | PPT |
| 7 | voltage distribution along string of suspension insulators, string efficiency, numerical | T1,T2 and R1 | PPT |
| 8 | Equalization of potential across each unit, method of improving string efficiency, insulator failure. | T1,T2 and R1 | PPT |

## Question Bank: Theory

1. Explain the effect of sag?
2. What are the different factors affecting the sag of transmission line. Derive an expression for the sag when supports are at unequal level.
3. Discuss the various properties of insulator and the insulating material used.
4. Write a short note on PLCC.
5. What is string Efficiency and explain method of calculating string efficiency.
6. Why the guard ring method improves the string efficiency of substation. Justify.

## Unit No.-IV: Resistance and Inductance of Transmission line

**Pre-requisites:-**

- Understanding of resistance and inductance of transmission line

**Objectives:-**

- To get the concept of GMR, GMD, resistance and inductance of three phase double circuit line and bundled conductor..

**Outcomes:-**

- After successfully completing this unit students will analyze and apply knowledge of resistance of transmission line and inductance determination

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Resistance of transmission line, skin effect and its effects | Chalk and talk | T4,T2 and R1 |
| 2 | Proximity effect, internal & external flux linkages of single conductor | Chalk and talk | T4,T2 and R1 |
| 3 | Inductance of single phase two wire line, inductance of three phase line with symmetrical and unsymmetrical spacing | Chalk and talk | T4,T2 and R1 |
| 4 | Concept of G.M.R. and G.M.D, necessity of transposition | Chalk and talk | T4,T2 and R1 |
| 5 | Inductance of three phase double circuit line with symmetrical and unsymmetrical spacing, inductance of bundled conductors. | Chalk and talk | T4,T2 and R1 |

**Question Bank: Theory**

1. Explain the transposition of conductors in transmission line and how it will affect the inductance of transmission line
2. What are the requirements of good conductor in transmission line.
3. State and explain the factors affecting design of transmission line
4. Write a shore note on skin effect and proximity effect.
5. Drive the expression of three phase overhead transmission line when conductors are unsymmetrically spaced but transposed.
6. Derive an expression for loop inductance of a single phase two wire overhead transmission line with conductors separated by a distance ‘d ‘meter and radius of each conductor ‘r’ meter.

**Unit No.-V: Capacitance of Transmission Line**

**Pre-requisites:-**

- Understanding of capacitance of Transmission line, concept of GMR and GMD

**Objectives:-**

- To understand capacitance of three phase transmission line with symmetrical and unsymmetrical spacing

**Outcomes: -** After successfully completing this unit students will be able to:

- To interpret calculation of capacitance for different configurationsof transmission line in power system.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Electric potential at single charged conductor, potential at conductor in a group of charged conductors | Chalk and talk | T3 and T2 |
| 2 | Capacitance of single phase line with effect of earth's surface on electric field | chalk and talk | T3 and T2 |
| 3 | Concept of G.M.R. and G.M.D for capacitance calculations | chalk and talk | T3 and T2 |
| 4 | capacitance of three phase line with symmetrical and unsymmetrical spacing | Chalk and talk | T3 and T2 |
| 5 | Capacitance of double circuit three phase line with symmetrical and unsymmetrical spacing. | Chalk and talk | T3 and T2 |
| 6 | Numericals | Chalk and talk | T3 and T2 |

## Question Bank: Theory

1. A transmission line has 2 parallel conductors 5m apart, radius of each conductor being 1.5cm Calculate capacitance of transmission line/Km.
2. Find the capacitance of a single phase transmission line between conductors and phase D neutral of 10 Km long consisting of two parallel wires of 2 cm in diameter and 4 m apart. Determine capacitance of same transmission line taking into account effect of ground between conductor and phase and neutral. The height of conductors above ground is 6m.
3. What is Ferranti effect? Deduce simple equation of voltage rise of unloaded line. Draw necessary phasor diagram.
4. What is the effect of load power factor on regulation and efficiency of Transmission line?
5. Derive the expression for capacitance of 3Φ transmission line when conductors are unsymmetrically spaced but transposed.

**Unit No.-VI**: **Performance of transmission line**

**Pre-requisites:-**

- Basic knowledge of Transmission line

**Objectives:-**

- Estimation of generalized circuit constant for short medium and long transmission line

**Outcomes: -** After successfully completing this unit students will be able to:

- Analyze the performance of transmission line and can estimate performance parameter.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| **1** | Classification of lines based on length and voltage levels such as short, medium and long lines. | T1,T2,T3 | PPT |
| **2** | Performance of short transmission line with voltage current relationship and phasor diagram, | T1,T2,T3 | PPT |
| **3** | Representation of medium lines as 'Nominal Pi' and 'Nominal Tee' circuits using R, L and C parameters. | T1,T2,T3 | PPT |
| **4** | Ferranti effect, Representation of 'Tee' and 'Pi' models of lines as two port networks | T1,T2,T3 | PPT |
| **5** | Evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, | T1,T2,T3 | PPT |
| **6** | Estimation of Efficiency & regulation of short & medium lines. | T1,T2,T3 | PPT |

**Question Bank: Theory**

1. With neat diagram and phasor diagram derive the relationship between sending end and receiving end quantities of medium transmission line consisting T model of line.
2. With neat diagram derive expression for ABCD constants of transmission line Draw neat phasor diagram hence state properties of short transmission line.
3. A single phase overhead transmission line delivers 1100KW at 33 kV at 0.8 p.f lagging. The total resistance and inductive reactance of transmission line are 10Ω and 15 Ω. Determine
   a) Sending end voltage
   b) Sending end power
   c) Transmission efficiency
   d) Voltage regulation
4. Classify transmission line based on voltage ,length and line parameters of short medium and long transmission line
6. A single phase transmission line transmits 1000KW at 10KV at 0.8pf lagging .It has total loop resistance of 2 Ω and inductive reactance of 3Ω.Determine
   a) Voltage regulation

b) Transmission efficiency

# Electrical Machines I (203146)

**Name of the Subject – Electrical Machines I**

| Weekly Work Load(in Hrs) | Lecture | Tutorial | Practical |
|---|---|---|---|
| | 03 | - | 02 |

| Online/ In-sem | Theory | Practical | Oral | Term-work | Total Marks | Credit |
|---|---|---|---|---|---|---|
| 30 | 70 | 50 | - | 25 | 150 | 04 |

**Unit 01: Transformers: (6 Hrs)**

Single phase Transformer: Concept of ideal transformer. Corrugated core transformer. Toroidal core Transformer, Useful and leakage flux, its effects. Resistance, leakage reactance and leakage impedance of transformer windings & their effects on voltage regulation and efficiency. Exact and approximate equivalent circuits referred to L.V. and H. V. side of the transformer. Phasor diagrams for no-load and on load conditions. Transformer ratings. Losses in a transformer, their variation with load, voltage & Frequency on no load losses Efficiency and condition for maximum efficiency. All day Efficiency. Auto transformers, their ratings and applications. Comparison with two winding transformers with respect to saving of copper and size.

**Unit 02: (6 Hrs)**

**Transformers:** Polarity test. Parallel operation of single-phase transformers, conditions to be satisfied, loadsharing under various conditions. & Welding Transformer

**Three Phase Transformers:** Standard connections of three phase transformers and their suitability for various applications, voltage Phasor diagrams and vector groups. Descriptive treatment of Parallel operation of three phase transformers Scott connection and V connections. Three winding (tertiary windings) transformers

**Unit 03: D.C. Machines (Part-1): (6 Hrs)**

Construction, main parts, magnetic circuits, poles, yoke, field winding, armature core, Armature windings: Simple lap and wave winding, commutator and brush assembly. Generating action, E.M.F equation, magnetization curve, Flashing of Generator. Motoring action. Types of DC motors, significance of back E.M.F, torque equation, working at no-load and on-load. Losses, power flow diagram and efficiency.

Descriptive treatment of armature reaction.

**Unit 04: D.C. Machines (Part-2): (6 Hrs)**

Characteristics and applications of D.C. Shunt and Series Motors, Starting of DC motors, study of starters for series and shunt motor, solid state starters, speed control of various types of DC motors. Commutation: Process of commutation, time of commutation, reactance voltage, different form Savitribai Phule Pune University Syllabus: SE Electrical (2019 Course) 30 of commutations, causes of bad commutation and its remedies (Descriptive treatment only)

**Unit 05: Three Phase Induction Motor: (6 Hrs)**

Construction: Stator, Squirrel cage & wound rotors. Production of rotating mmf. Principle of working, simplified theory with constant air gap flux; slip, frequency of rotor emf and rotor currents, mmf produced by rotor currents, its speed w.r.t. rotor and stator mmf. Production of torque, torque-slip relation, condition for maximum torque, torque-slip Characteristics, effect of rotor resistance on torque-slip characteristics. Relation between starting torque, full load torque and maximum torque. Losses in three phase induction motor, power-flow diagram, Relation between rotor input power, rotor copper loss & gross mechanical power developed, efficiency.

**Unit 06: Three Phase Induction Motor: (6 Hrs)**

Induction motor as a generalized transformer; phasor diagram. Exact & approximate equivalent circuit. No load and blocked rotor tests to determine the equivalent circuit parameters and plotting the circle diagram. Computation of performance characteristics from the equivalent circuit and circle diagram. Performance curves. Necessity of starter for 3-phase induction motors. Starters for slip-ring and cage rotor induction motors, comparison of various starters. Testing of three phase induction motor as per IS 325 & IS 4029.

**Industrial Visit:** Minimum One visit to above machines manufacturing industry (mentioned in syllabus) is recommended.

**List of Experiments:**

**Compulsory Experiments:**

1. O.C. and S.C. test on single phase Transformer a. Determination of equivalent circuit parameters from the test data b. Determination of voltage regulation and efficiency

2. Parallel operation of two single phase transformers and study of their load sharing under various conditions of voltage ratios and leakage impedance.

3. Speed control of D.C. Shunt motor and study of starters.

4. Load test on 3-phase induction motor.

**Any four experiments are to be conducted of following experiments:**

1. Polarity test on single phase and three phase transformer.

2. Brake test on D.C. Shunt motor

3. Load characteristics of D.C. series motor.

4. Hopkinson's test on D.C. shunts machines.

5. No load & blocked-rotor test on 3-phase induction motor: a) Determination of parameters of equivalent circuit. b) Plotting of circle diagram.

6. Calculation of motor performance from (a) & (b) above.

7. Determination of sequence impedance of the transformer

8. To study Sumpner's test.

9. Measurements of non-sinusoidal current waveform of transformer at no load

10. Swinburne Test on DC shunt Motor.

**Text Books:**

[T1] Edward Hughes "Electrical Technology", ELBS, Pearson Education.

[T2] Ashfaq Husain, "Electrical Machines", Dhanpat Rai& Sons.

[T3] S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill publishing Co. Ltd, 2nd Edition.

[T4] Nagrath & Kothari, "Electrical Machines", Tata McGraw Hill.

[T5] Bhag S Guru, Husein R. Hiziroglu, "Electrical Machines", Oxford University Press.

[T6] K Krishna Reddy, "Electrical Machines- I and II", SCITECH Publications (India) Pvt. Ltd. Chennai.

**Reference Books:**

[R1] A.E. Clayton and N. N. Hancock, "Performance and Design of Direct Current Machines", CBS Publishers, Third Edition.

[R2] A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, "Electrical Machines", TataMcGraw Savitribai Phule Pune University Syllabus: SE Electrical (2019 Course) 31 Hill Publication Ltd., Fifth Edition.

[R3] A.S. Langsdorf, "Theory and performance of DC machines", Tata McGraw Hill.

[R4] M.G. Say, "Performance and Design of AC. Machines", CBS Publishers and Distributors.

[R5] Smarajit Ghosh, "Electrical Machines", Pearson Education, New Delhi.

[R6] Charles I Hubert, "Electrical Machines Theory, Application, & Control", Pearson Education, New Delhi, Second Edition.

**Course Objectives**

- To understand energy conversion process.
- To understand selection of machines for specific applications.
- To understand the construction, principle of operation of transformers, DC Machine & Induction Machine.
- To test & analyze the performance of machine**s.**

**Course Outcomes**

After successfully completing the course students will be able to:

1. Students will recognize and describe construction and working of single phase transformers
2. Analyze working, controlling and applications of single and three phase transformers under different operating conditions.
3. Students will evaluate construction, performance parameters, working of d c machines.
4. Students will evaluate techniques of speed control and applications of d.c. machines under different operating conditions
5. Students will analyze construction; working and operation three phase Induction motor.
6. Students will analyze working and operation and applications under different operating conditions of three phase Induction motor, plot and evaluate its performance parameters

**Academic Activity Planner**

| Units | Unit Test1 (10marks) | Unit Test2 (10marks) | Assignment No:1 (10marks) | Assignment No:2 (10marks) | OBT : (10marks) | MCQ (10marks) |
|---|---|---|---|---|---|---|
| 1 | ✓ | | | | | |
| 2 | | ✓ | | | | |
| 3 | | | ✓ | | | |
| 4 | | | | ✓ | | |
| 5 | | | | | ✓ | |
| 6 | | | | | | ✓ |

## Teaching Plan

### Teaching plan as per University Syllabus

| Sr.No. | Unit | Broad Topics to be Covered | Total Lecture Planned |
|---|---|---|---|
| 1 | I | Transformers | 08 |
| 2 | II | Transformers | 06 |
| 3 | III | D.C. Machines | 08 |
| 4 | IV | D.C. Machines | 08 |
| 5 | V | Three phase induction motor | 08 |
| 6 | VI | Three phase induction motor | 06 |

**Unit wise Lecture Plan**

**Unit No.-I: Transformers**

**Pre-requisites:-**

- Basic working principle of transformer, laws of Electromagnetic induction

**Objective :-**

- To understand construction and working of transformer.

**Outcome :**

- Students will recognize and describe construction and working of transformer.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Single phase Transformer: Concept of ideal transformer. Corrugated core transformer. Useful and leakage flux, its effects. | T2,T3,R6,R5 | Chalk & Talk |
| 2 | Resistance, leakage reactance and leakage impedance of transformer windings & their effects on voltage regulation and efficiency | T2,T3,R6,R5 | Chalk & Talk |
| 3 | Exact and approximate equivalent circuits referred to L.V. and H. V. side of the transformer | T2,T4,R6,R5 | PPT |
| 4 | Phasor diagrams for no-load and on load conditions. Transformer ratings. | T2,T3,R6,R5 | PPT |
| 5 | Losses in a transformer, their variation with load. Efficiency and condition for maximum efficiency | T2,T4,R6,R5 | Chalk & Talk |
| 6 | Open circuit and short circuit tests, determination of equivalent circuit parameters from the test | T2,T4,R6,R5 | PPT |
| 7 | determination of voltage regulation and efficiency. Autotransformers, their ratings and applications | T2,T3,R6,R5 | Chalk & Talk |
| 8 | Comparison with two winding transformer with respect to saving of copper and size. | T2,T4,R6,R5 | Chalk & Talk |
| 9 | Rubrics | | |

**Question Bank: Theory**

1. Explain the Construction, in detail, of 1-phase transformer with neat diagram
2. Differentiate between core and shell type transformer
3. Why transformer is rated in KVA not in KW?
4. Drive the induced EMF equation of a transformer. What is Voltage Regulation?
5. Draw the Exact phasor diagram of Transformer on full load
6. What are the various losses in the transformer?
7. Write the characteristics of an ideal transformer
8. Compare bank of 3 single phase transformer with a single 3 phase transformer.
9. Explain the two tests used for determining the losses in single phase transformer (Discuss the tests to find out the iron loss and copper loss in a transformer with justifications
10. Develop equivalent circuit of a 1-phase transformer. Draw the phasor diagrams for no-load and load conditions

## Unit No.-II: Transformers

**Pre-requisites:-**

- Construction and working of transformer.

**Objectives:-**

- To understand various methods to determine regulation and efficiency of transformer

**Outcomes:-**

- After successfully completing this unit students will be able to analyze working, controlling and applications of transformer, Autotransformer.

| Lecture No. | Details of the Topic to be covered | References | Mode of delivery |
|---|---|---|---|
| 1 | Polarity test. Parallel operation of single phase transformers | T2,T3,R6,R5 | Chalk & Talk |
| 2 | conditions to be satisfied, load sharing under various conditions. | T4,T3,R6,R5 | Chalk & Talk |
| 3 | Standard connections of three phase transformers and their suitability for various applications | T2,T4,R6,R5 | PPT |
| 4 | Voltage phasor diagrams and vector groups. | T2,T3,R6,R5 | PPT |
| 5 | Descriptive treatment of Parallel operation of three phase transformers Scott connection and V connections. | T3,T4,R6,R5 | Chalk & Talk |
| 6 | Three winding (tertiary windings) transformers | T2,T4,R6,R5 | PPT |
| 7 | Rubrics | | |

1. Describe an auto transformer including its points such as definition, comparison with two winding transformer, saving of copper and its applications. Write advantages and applications of auto transformer.
2. Discuss open delta connections of transformers with necessary circuit and vector diagrams. And its advantages.
3. Explain the conditions of parallel operation of three phase transformers. How three phases to two phase transformation of transformer is obtained?
4. Define Transformation Ratio.
5. In no load test of single phase transformer, the following test data were obtained: Primary voltage: 220V; Secondary voltage: 110V; Primary current: 0.5A; Power input: 30W. Find the following: (i) The turns ratio (ii) The magnetizing component of no-load current (iii) It's working (or loss) component (iv) The iron loss Resistance of primary winding = 0.6Ω.
6. Obtain the equivalent circuit of a 200/400 V ,50 Hz,1 Phase Transformer from the following test data O.C. Test : 200 V,0.7 A,70 W - on L.V. side S.C. Test : 15 V, 10 A, 85 W -on H.V. side Calculate the secondary voltage when delivering 5 KW at 0.8 p. f. lagging , the primary voltage being 200V
7. A 100 KVA, 50 Hz, 440/11000 V, 1- phase transformer has an efficiency of 98.5% when supplying full-load current at 0.8 power factor lagging and an efficiency of 99% when supplying half full load current at unity power factor. Find the core losses and the copper losses corresponding to full-load current. At what value of load current will the maximum efficiency be attained

**Unit No.-III: D.C. Machines**

**Pre-requisites :-**

- Flemings left hand/right hand rule
- Laws of electromagnetic induction

**Objectives :-**

- To understand construction and working of DC machines
- To understand concept of armature reaction

**Outcomes: -**

After successfully completing this unit students will be able to:

- Evaluate different losses occurred in DC machines & its efficiency.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| **1** | Construction, main parts, magnetic circuits, poles, yoke, field winding, armature core | T4,T2,T3,R6,R1 | Chalk & Talk |
| **2** | Armature windings : Simple lap and wave winding, commutator and brush assembly | T2,T4,T3,R6,R5 | Chalk & Talk |
| **3** | Generating action, e.m.f equation | T2,T4,R6,R5 | PPT |
| **4** | Magnetization curve, motoring action. Types of DC motors | T2,T3,R6,R1 | PPT |
| **5** | significance of back e.m.f. torque equation | T3,T4,R6,R5 | Chalk & Talk |
| **6** | working at no-load and on-load., Losses | T2,T4,R6,R1 | PPT |
| **7** | Power flow diagram and efficiency. | T4,T3,R6,R5 | Chalk & Talk |
| **8** | Descriptive treatment of armature reaction. | T2,T4,R6,R1 | Chalk & Talk |
| **9** | Rubrics | | |

1. Draw and explain characteristics of D.C. shunt and D.C. series motor.
2. A 230V, 4 pole lap wound d.c. shunt motor takes a no load current of 4A when running at 1200 rpm. The resistance of armature winding is 0.1ohm and shunt resistance is 115ohm. Total brush contact drop is 2V. It takes current of 60A on full load. Calculate full load speed. Assume that flux gets weakened by 5% on full load condition due to armature reaction.
3. A 200V, 4 pole, lap wound d.c. shunt motor has 800 conductors on its armature. The resistance of armature winding is 0.5ohm and that of shunt winding is 200ohm. The motor takes current of 21A and flux per pole is 30mWb. Find the speed and gross torque developed in armature.
4. Why is a starter required for d.c. motor? Discuss the working of three-point starter with the help of neat schematic.
5. Explain any two methods of speed control of d.c shunt motor
6. Draw and Explain Characteristics of DC shunt Generator.
7. Explain principle of operation of DC generator.
8. A 4 pole, 50 KW, 250V wave wound Shunt Generator has 400 armature conductor brushes are given a lid of 4 commutator segment. Calculate the Demagnetization ampere –turn per pole if the shunt field resistance is 50Ω. Also calculate the Extra shunt field turns per pole to neutralize the demagnetization.
9. Explain the effect of armature reaction in a Dc shunt Generator. How are its Demagnetizing and Cross magnetizing ampere turns calculated.
10. Explain the process of commutation in DC machine.

**Unit No.-IV: D.C. Machines**

**Pre-requisites:-**

- Basic working principle of machines and its rotating theory

**Objectives:-**

- To study various speed control methods of DC motors.
- To study different types of starters for DC motors
- To impart various applications of DC motors.

**Outcomes:-**

After successfully completing this unit students will be able to:

- evaluate performance parameters, working and applications of DC motor.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| **1** | Characteristics and applications of D.C. Shunt and Series Motors | T4,T2,T3,R6,R5 | Chalk & Talk |
| **2** | Starting of DC motors, study of starters for series and shunt motor | T2,T4,T3,R6,R5 | Chalk & Talk |
| **3** | solid state starters, speed control of various types of DC motors. | T3,T2,T4,R6,R5 | PPT |
| **4** | Process of commutation, time of commutation, reactance voltage | T2,T3,R6,R5 | PPT |
| **5** | straight line commutation, commutation with variable current density , under and over commutation | T3,T4,R6,R5 | Chalk & Talk |
| **6** | causes of bad commutation and remedies, inter poles | T2,T4,R6,R5 | PPT |
| **7** | compensating windings | T4,T3,R6,R5 | Chalk & Talk |
| **9** | Rubrics | | |

1. Describe different parts of a d.c. machine; their material and functions with the help of a neat diagram.(Draw schematic diagram of a dc machine with labels. State the functions of (i) pole shoe, (ii) commutator and (iii) yoke.)
2. Explain the phenomenon of armature reaction in a d.c. machine.
3. Explain different methods to neutralize the effect of armature reaction.
4. Differentiate between self-excited and separately excited d.c. machines. Draw the load characteristic of dc shunt and series generator.
5. Draw the load characteristics of shunt, series and compound generators.
6. Discuss load characteristics (current-torque) of d.c. shunt, series, and compound motors.

   Also state their applications.
7. Explain working principle of d.c. motor. Derive the condition for maximum Power
8. What is commutation? Give remedies for commutation.

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**Unit No.-V: Three phase induction motor**

**Pre-requisites:-**

- Basic working principle of machines and its rotating theory
- Laws of electromagnetic induction

**Objectives:-**

- To understand construction and working of induction motor.
- To understand relation between different power stages of induction motor.

**Outcomes: -**

After successfully completing this unit students will be able to:

- evaluate different losses occurred in Induction motor & its efficiency.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Production of rotating mmf by 3-phase balanced voltage fed to a symmetrical 3-phase winding. Construction: Stator and its 3-phase windings. | T4,T3,R1, R5 | Chalk & Talk |
| 2 | Types of rotors: Squirrel cage & wound rotors. Principle of working, simplified theory with constant air gap flux | T4,T3,R1, R5 | Chalk & Talk |
| 3 | slip, frequency of rotor emf and rotor currents, mmf produced by rotor currents, its speed w.r.t. rotor and stator mmf. | T3,T4,R1, R5 | PPT |
| 4 | Production of torque, torque-slip relation, condition for maximum torque, torque-slip Characteristics, effect of rotor resistance on torque-slip characteristics. | T4,T3,R1, R5 | PPT |
| 5 | Relation between starting torque, full load torque and maximum torque. | T3,T4,R1, R5 | Chalk & Talk |
| 6 | Losses in three phase induction motor, power-flow diagram. | T2,T4,R1, R5 | PPT |
| 7 | Relation between rotor input power, rotor copper loss & gross mechanical power developed, efficiency | T4,T3,R1, R5 | Chalk & Talk |
| 9 | Rubrics | | |

## Question Bank: Theory

1. Show the power development stages in an three phase induction motor.
2. Draw the equivalent circuit of an three phase induction motor.
3. What is an induction generator?
4. Sketch and explain the torque slip characteristics of a 3-phase cage and slip ring induction motors. Show the stable region in the graph.
5. Give Relation between starting torque, full load torque and maximum torque.
6. State and explain different losses occurred in induction motor.
7. With the help of diagrams, explain how a rotating magnetic field is produced in the air gap of a 3-phase induction motor.
8. List the differences between squirrel cage and slip ring rotor.
9. Define slip of induction motor.
10. A 3-phase induction motor does not run at synchronous speed. Why?
11. Why is the no-load current drawn by 3-phase induction motor so high?

**Unit No.**-VI: **Three phase induction motor**

**Pre-requisites:-**

- Basic working principle of machines and its rotating theory

**Objectives:-**

- To study different types of starters for induction motor.
- To impart various applications of induction motor.

**Outcomes: -**

After successfully completing this unit students will be able to:

- evaluate performance parameters, working and applications of induction motor.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| **1** | Induction motor as a generalized transformer; phasor diagram. | T4,T3,R1,R6 | Chalk & Talk |
| **2** | Exact & approximate equivalent circuit. No load and blocked rotor tests to determine the equivalent circuit parameters | T4,T3,R1,R6 | Chalk & Talk |
| **3** | plotting the circle diagram | T3,T4,R1,R6 | PPT |
| **4** | Computation of performance characteristics from the equivalent circuit and circle diagram. Performance curves. | T4,T3,R1,R6 | PPT |
| **5** | Necessity of starter for 3-phase induction motors. Starters for slip-ring and cage rotor induction motors; | T3,T4,R1,R6 | Chalk & Talk |
| **6** | stator resistance starter, auto transformer starter, star delta starter | T2,T4,R1,R6 | PPT |
| **7** | Rotor resistance starter. D.O.L. starter and soft starting, with their relevant torque and current relations. | T4,T3,R1,R6 | Chalk & Talk |
| **8** | Comparison of various starters. , testing of three phase induction motor as per IS 325 & IS 4029. | T4,T3,R1,R6 | Chalk & Talk |
| **9** | Rubrics | | |

## Question Bank: Theory

1. Discuss the equivalent circuit of 3-phase induction motor
2. How is the circle diagram useful for estimating the working conductions of an induction motor?
3. From an equivalent circuit, derive the various power equation of an induction motor.
4. Explain the tests required to be performed to obtain the data for the circle diagram.
5. Draw and explain in detail DOL starter.
6. Explain-Induction motor as a generalized transformer.
7. Explain the effect of slip on the following rotor parameters.
    a. frequency ii) induced emf
    b. current iv) power factor v)reactance
8. Draw the diagram of an auto-transformer starter used for 3-phase induction motor and explain its operation

# NETWORK ANALYSIS

# (203147)

**Name of Subject: NETWORK ANALYSIS**

| Weekly Work Load (in Hrs.) | Lecture | Tutorial | Practical |
|---|---|---|---|
| | 03 | - | 01 |

| Online/ In-sem | Theory | Practical | Oral | Term-work | Total Marks | Credit |
|---|---|---|---|---|---|---|
| 30 | 70 | | - | 25 | 125 | 04 |

## Syllabus:

**Unit 01 : Types of Network, Mesh and Nodal analysis (6 Hrs)**

Lumped and Distributed, Linear and Nonlinear, Bilateral and Unilateral, Time-variant and Time invariant. Independent and Dependent (controlled) voltage and current sources. Concept of voltage and current divider, Source transformation and shifting. Network Equations: Network equations on Loop basis and Node basis, choice between Loop analysis and Nodal analysis. Concept of super node and super mesh, mutual inductance, Dot convention for coupled circuits, Concept of duality and dual networks..

**Unit 02 : Network Theorem (6 Hrs)**

Superposition, Thevenin, Norton, Maximum Power Transfer Theorem, Reciprocity, Millman theorems applied to electrical networks with all types of sources. Graph Theory: Tree, Co-tree, Incidence matrix, F-cutest Matrix, Tie set B Matrix

**Unit 03 : Transients in RLC circuit (6 Hrs)**

Solutions of differential equations and network equations using classical method for R-L, R-C and R-L-C circuits, Initial and Final Condition (series and parallel).

**Unit 04 : Laplace Transform (6 Hrs)**

Basic Properties of Laplace Transform, Laplace Transform of Basic R, L and C components, Solutions of differential equations and network equations using Laplace transform method for RL, R-C and R-L-C circuits (series and parallel), Inverse Laplace transforms, transformed

networks with initial conditions. Analysis of electrical circuits with applications of step, pulse, impulse & ramp functions, shifted & singular functions the convolution integral, application of initial and final value theorem

**Unit 05 : Two port network and Filters (6 Hrs)**

Two Port Network: Z, Y, H and transmission parameters, Interrelations between parameters. Introduction to passive filters, low pass filters, high pass filters and m-derived LPF and HPF filters and design

**Unit 06: Network Functions (6Hrs)**

Poles and Zeros: Terminal pairs or ports, network functions for the one port and two ports, the calculation of network functions, general networks. Poles and zeros of network functions, Restrictions on poles and zeros locations for transfer functions and driving point function, Time –domain behavior from the pole and zero plot. Stability of active networks. Parallel Resonance, Resonance frequency, Quality factor, Current and resonance.

**Text Books:**

[T1] Network Analysis Third Edition by M. E. Van Valkenburg, Prentice Hall of India Private Limited.

[T2] Network Analysis & Synthesis by G. K. Mittal, Khanna Publication.

[T3] Network Analysis and Synthesis by Ravish R Singh, McGraw Hill.

[T4] Introduction to Electric Circuits by Alexander & Sadiku, McGraw Hill.

[T5] Introduction to Electric Circuits by S. Charkarboorty, Dhanpat Rai & Co.

[T6] Fundamentals of Electrical Networks by B.R.Gupta & Vandana Singhal- S.Chand Publications 8. Electrical Circuit Analysis 2nd Edition by P. Ramesh babu, Scitech Publication India Pvt Ltd.

**Reference Books:**

[R1] Network Analysis by Cramer , McGraw Hill Publication.

[R2] Engineering Circuit Analysis by William H. Hayt, Jr. Jack E. Kemmerly, McGraw Hill Publication.

[R3] Schaum's Outline of Electric Circuits, McGraw-Hill Education; 7 edition

**Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:**

1.www.nptel.ac.in

2.www.electrical4you.com

3. www.electronicspani.com

**Pre-requisite:**

Terminology of electrical networks, Laplace transforms, linear differential equations.

**Course Objectives:**

To develop the strong foundation for Electrical Networks.

To develop analytical qualities in Electrical circuits by application of various theorems.

To understand the behavior of circuits by analyzing the transient response using classical methods and Laplace Transform approach.

To apply knowledge of Network theory for analysis of 2-port networks and design of other circuits like filters.

**Course Outcomes:**

CO1: Students will be able to characterize types of networks and formulate network equations for loop and nodal analysis.

CO2: Students will be able to define and implement network theorems to solve various circuits.

CO3: Students will be able to analyze transient response of basic circuits using classical method.

CO4: Students will be able to analyze transient response of basic circuits using Laplace transform.

CO5: Students will be able to describe and synthesize two-port network, network functions and identify stability of networks.

CO6: Students will be able to define, recognize and design passive filters.

## Academic Activity Planner

| Units | Unit Test1 (10marks) | Unit Test2 (10marks) | Assignment No:1 (10marks) | Assignment No:2 (10marks) | OBT : (10marks) | MCQ (10marks) |
|---|---|---|---|---|---|---|
| 1 | ✓ | | | | | |
| 2 | | ✓ | | | | |
| 3 | | | ✓ | | | |
| 4 | | | | ✓ | | |
| 5 | | | | | ✓ | |
| 6 | | | | | | ✓ |

**Teaching plan as per University Syllabus:**

| Sr.No. | Unit | Broad Topics to be Covered | Total Lecture Planned |
|---|---|---|---|
| 1 | I | Types of Network, Mesh and Nodal analysis | 06 |
| 2 | II | Network Theorems | 06 |
| 3 | III | Transients in RLC circuit | 06 |
| 4 | IV | Laplace Transform | 06 |
| 5 | V | Two port network and Filters | 06 |
| 6 | VI | Network Functions | 06 |

## Unit wise Lecture Plan

### Unit No.-I: Types of Network, Mesh and Nodal analysis

**Pre-requisites:**

- Terminology of electrical networks

**Objectives:**

- To develop the strong foundation for Electrical Networks

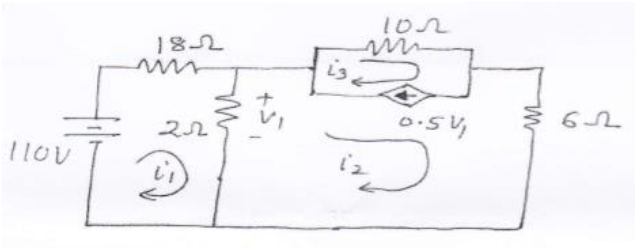
**Outcomes:**

Students will be able to characterize types of networks and formulate network equations for loop and nodal analysis.

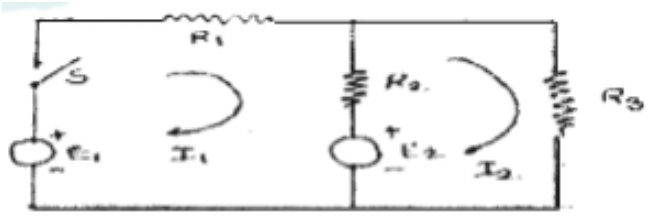
| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Lumped and Distributed, Linear and Nonlinear, Bilateral and Unilateral, Time-variant and Time invariant. | T1,T2,T3,T4 R1,R3 | Chalk and Talk |
| 2 | Independent and Dependent (controlled) voltage and current | T1,T2,T3,T4 R1,R3 | Chalk and Talk |
| 3 | Concept of voltage and current | T1,T2,T3,T4 | Chalk and Talk |
| 4 | Network Equations: Network | T1,T2,T3,T4 | Chalk and Talk |
| 5 | Nodal analysis. Concept of super | T1,T2,T3,T4 | Chalk and Talk |
| 6 | Mutual inductance, Dot convention | T1,T2,T3,T4 | Chalk and Talk |

**Question Bank: Theory- Unit: I**

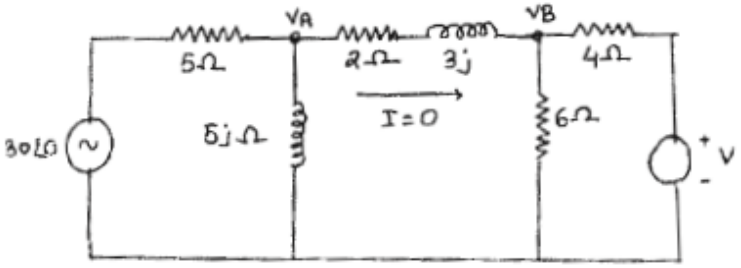
1) Explain
    1. Dependent and independent sources
    2. Active and passive networks
    3. Unilateral and Bilateral networks
    4. Lumped and distributed networks
    5. Linear and Nonlinear networks
2) Explain: On what basis you select nodal analysis or mesh analysis for solving any given network
3) Explain: The concept of super mesh and super node with example.
4) Define: Mutual inductance and explain dot convention with neat circuit diagram.
5) Explain principle of duality with suitable example.
6) What are coupled circuits?
7) What are coupled coils?
8) Define self-inductance and mutual inductance.
9) Define coefficient of coupling.
10) State dot convention for coupled coils.
11) Define:
    1. Graph
    2. Tree
    3. Node
    4. Link
    5. Twig
12) Explain the following:
    1. Incidence Matrix
    2. Tie-set Matrix
    3. Cut-set matrix
13) Find current through 10Ω resistance using mesh analysis.



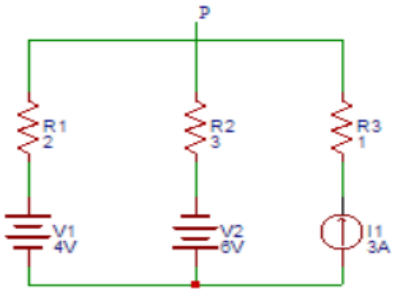

14) By using graphical method, find dual of the given network:



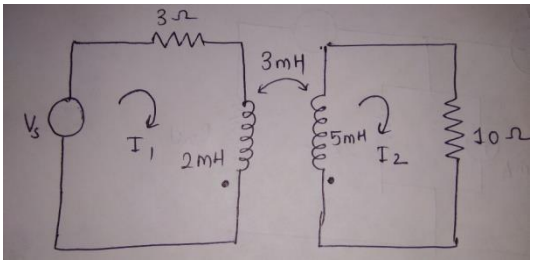

15) For the network shown in figure, determine voltage 'V' which results in zero current through (2+3j) Ω impedance.




16) Find the voltage at node P in the figure shown



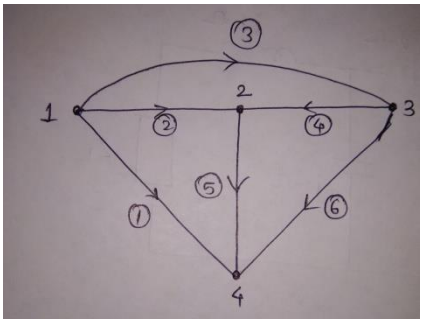

17) Solve the circuit shown below for $I_2$ where, $V_S$=100 V and ω= 5000 rad/s



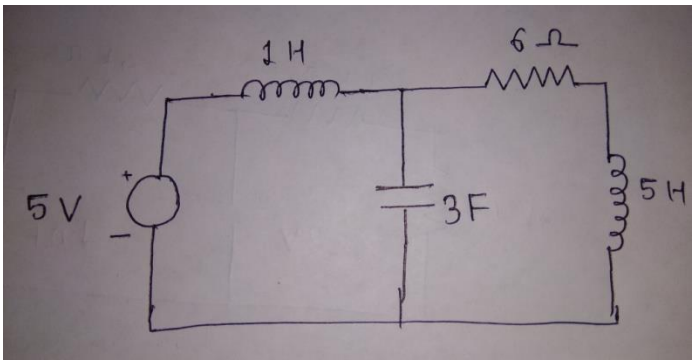
18) The Incidence matrix of a certain network graph is given. Calculate the number of possible trees

$$Ai = \begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & -1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & -1 & -1 & -1 \\ 0 & 0 & 0 & 1 & 0 & 0 & -1 & 0 \end{bmatrix}$$

19) For the following network graph find out corresponding incident, tie-set and cut-set matrix.




20) Draw dual network of the following network



**Unit No.-II:**

**Network Theorems**

**Pre-requisites:**

- Terminology of electrical networks

**Objectives:**

- To develop analytical qualities in Electrical circuits by application of various theorems

**Outcomes:** After successfully completing this unit

- Students will be able to define and implement network theorems to solve various circuits.

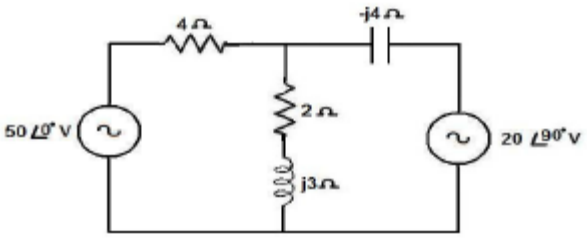
| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Superposition, | T2,T3,T4 R1,R3 | Chalk and Talk |
| 2 | Thevenin, Norton, | T2,T3,T4 R1,R3 | Chalk and Talk |
| 3 | Maximum Power Transfer Theorem, Reciprocity, | T2,T3,T4 R1,R3 | Chalk and Talk |
| 4 | Millman theorems applied to electrical networks with all types of sources. | T2,T3,T4 R1,R3 | Chalk and Talk |
| 5 | Graph Theory : Tree ,Co-tree, | T2,T3,T4 R1,R3 | Chalk and Talk |
| 6 | Incidence matrix ,F-cutest Matrix, Tie set B Matrix | T2,T3,T4 R1,R3 | Chalk and Talk |

**Question Bank: Theory: Unit 2:**

**1)** State and explain following theorem along with its limitation:

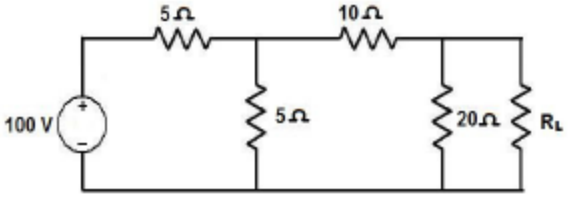
1. Superposition Theorem,
2. Thevenin's Theorem,
3. Norton Theorem,
4. Maximum Power Transfer Theorem,
5. Reciprocity Theorem,
6. Millman Theorem

2) (a) For the circuit shown, determine the current in (2+j3) ohm by using superposition theorem.



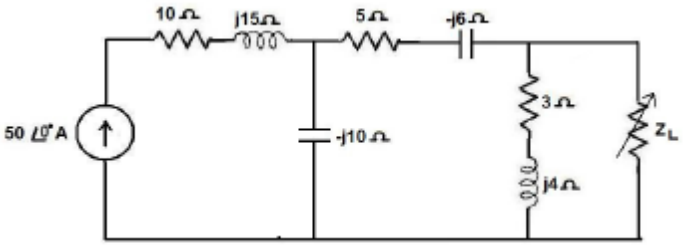

(b) State and prove Norton's theorem.

3) (a) Find the value of $R_L$ so that maximum power is delivered to the load resistance shown in figure

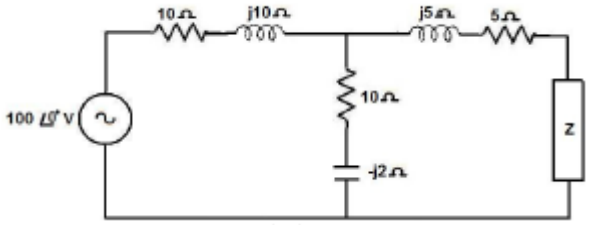



(b) State and explain reciprocity theorem.

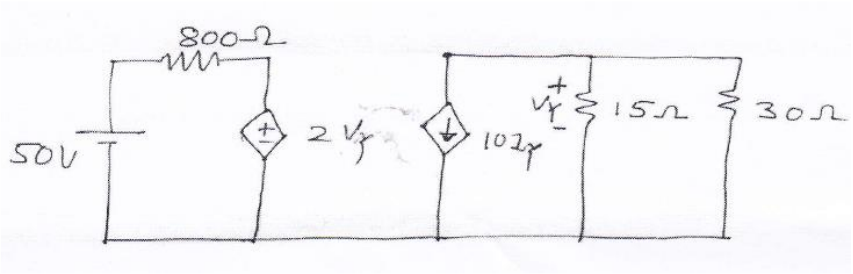
4) Determine the maximum power delivered to the load in the circuit.



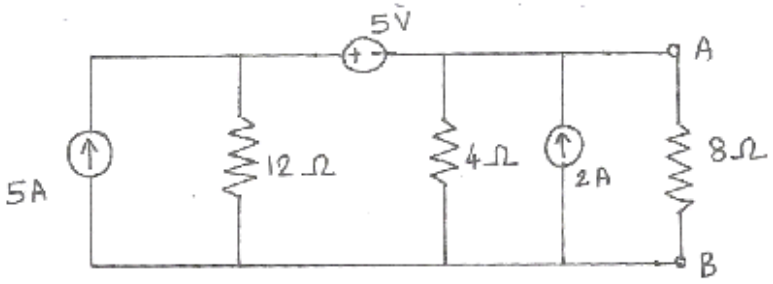
5) Find the value of impedance Z so that maximum power will be transferred from source to load for the circuit shown



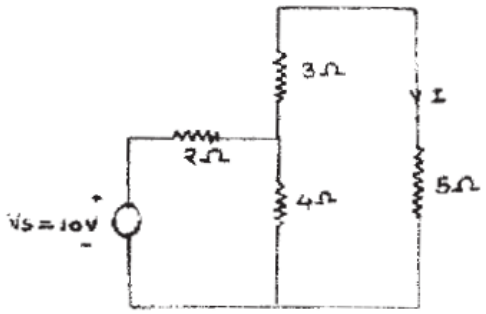

6) Find current through 30Ω resistance by using Thvenins Theorems as shown in fig:



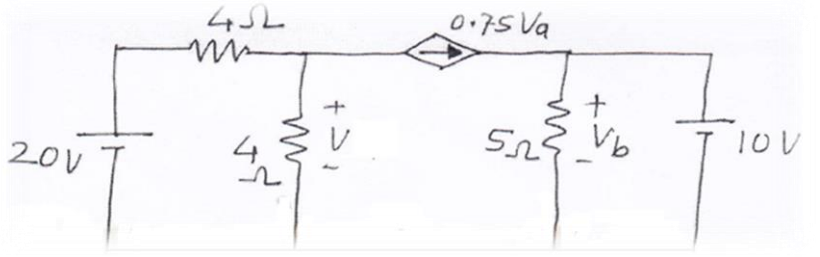

7) Find current through 8Ω resistance by Norton's theorem.



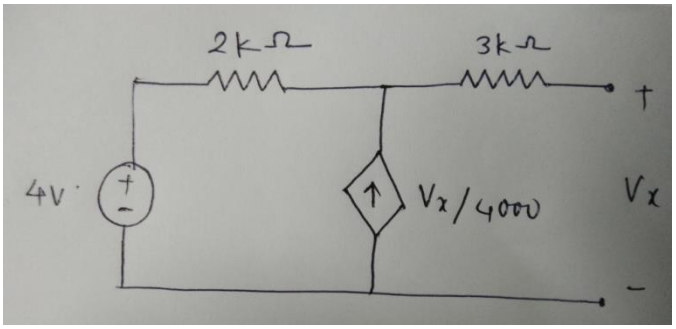

8) Verify Reciprocity Theorem for voltage and current shown in the figure:



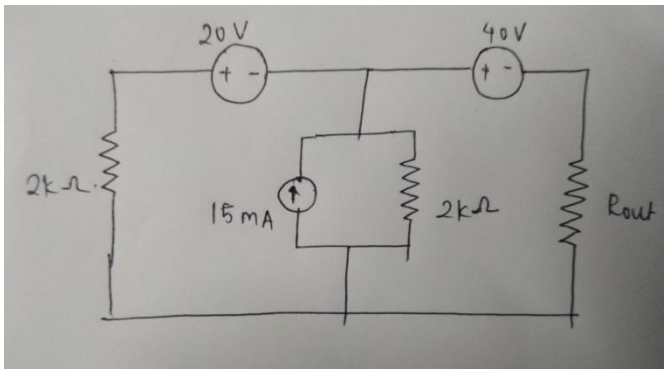

9) Find $V_a$ and $V_b$ using Superposition Theorem:



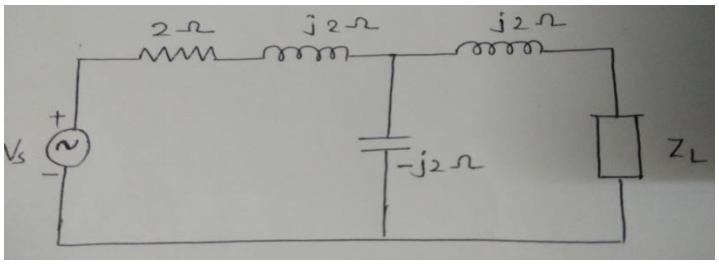

10) Find Thevenin's equivalent of the circuit given below:



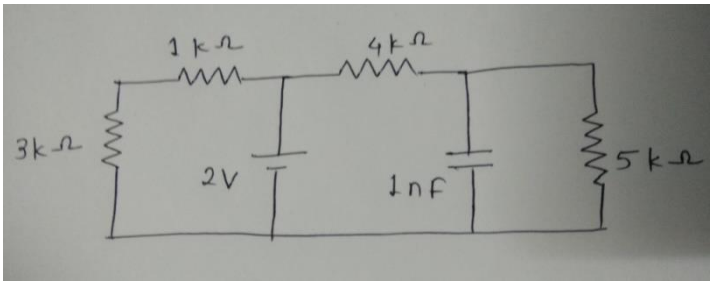

11) Find the power delivered by 40 V source:



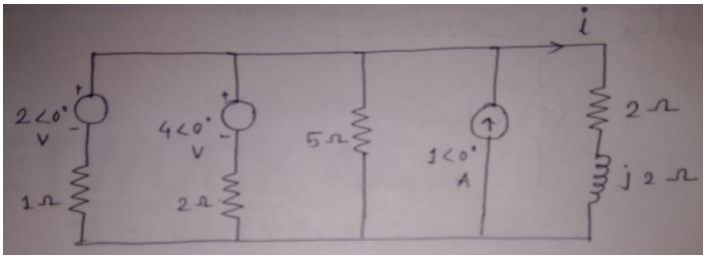

12) Find $Z_L$ such that maximum power is transferred to it




13) Find Norton's equivalent of following circuit with respect to the capacitor of 1 nF:




14) Calculate the current flowing through (2+j2) Ω branch using Superposition theorem:


i
2∠0°
V
1Ω
4∠0°
V
2Ω
5Ω
1∠0°
A
2Ω
j 2Ω

## Unit No.-III: Transients in RLC circuit

**Pre-requisites:**

- Differential calculus, linear differential equations,

**Objectives:**

- To understand the behavior of circuits by analyzing the transient response using Classical methods approach.

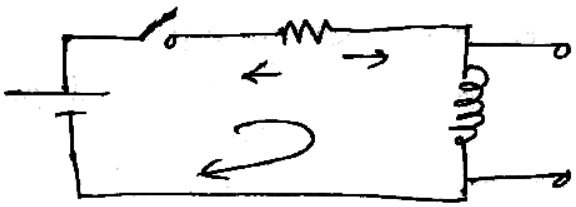
**Outcomes:** After successfully completing this unit

- Students will be able to analyze transient response of basic circuits using classical method.

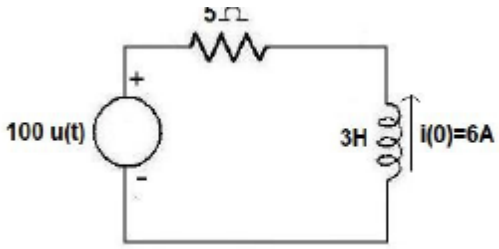
| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Solutions of differential equations and network equations using classical method | T1,T3 R2,R3 | PPT, Chalk and Talk |
| 2 | Solutions of differential equations and network equations using classical method | T1,T3 R2,R3 | Chalk and Talk |
| 3 | Solutions of differential equations and network equations using classical method | T1,T3 R2,R3 | PPT, Chalk and Talk |
| 4 | Solutions of differential equations and network equations using classical method | T1,T3 R2,R3 | Chalk and Talk |
| 5 | Solutions of differential equations and network equations using classical method | T1,T3 R2,R3 | Chalk and Talk |
| 6 | Initial and Final Condition (series and parallel). | T1,T3 R2,R3 | Chalk and Talk |

**Question Bank: Theory Unit No.-III**

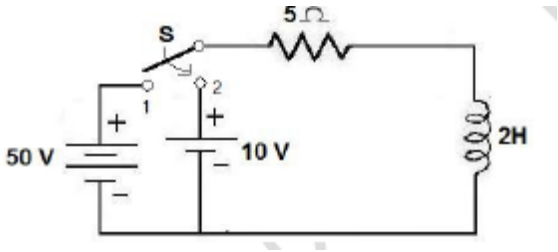
1) Write a short note on initial and final conditions in the network.
2) Obtain the expression for capacitor voltage in a RC series circuit connected to a d.c. voltage V for $t > 0$. Assume initial charge across capacitor as zero. Also sketch the response graph for the current through capacitor and from the graph define time constant of the circuit.
3) For the network shown in Fig. 7, find the expression for current $i(t)$ when the switch is closed at $t = 0$ by using classical method. Also obtain the expression for VR($t$) and VL($t$). Assume initial current in the inductance is zero.



4) Make a table for transient response of RL and RC(driven and un-driven circuit) and all responses of RLC series and RLC parallel circuit.
5) What is critical resistance?
6) What is natural and damped frequency?
7) What is an initial condition?
8) What is the steady state value?
9) What are critical frequencies? Why they are so called?
10) Distinguish between steady state and transient response.
11) In the circuit of the figure shown below, find the expression for the transient currentand the initial rate of growth of the transient current




12) In the circuit shown in figure, switch S is in position 1 for a long time and brought to position 2 at time t=0. Determine the circuit current.




13) A resistance R and 2 microfarad capacitor are connected in series across a 200Vdirect supply. Across the capacitor is a neon lamp that strikes at 120V. Calculate to make the lamp strike 5 sec after the switch has been closed. If R = 5Megohm,how long will it take the lamp to strike?

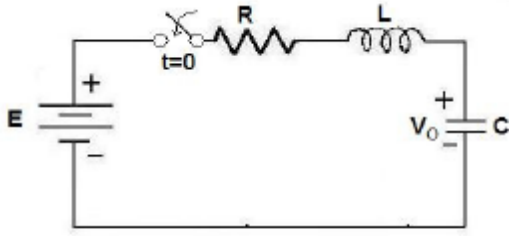
14) A Series RLC circuits has R=50 ohm, L= 0.2H, and C = 50 microfarad. Constantvoltage of 100V is impressed upon the circuit at t=0. Find the expression for thetransient current assuming initially relaxed conditions.

15) A Series RLC circuits with R=300 ohm, L=1H and C=100x10-6F has a constantVoltage of 50V applied to it at t= 0. Find the maximum value of current (Assumezero initial conditions6. For a source free RLC series circuit, the initial voltage across C is 10V and the initialcurrent through L is zero. If L = 20mH, C=0.5 microfarad and R=100 ohm. Evaluate i(t).

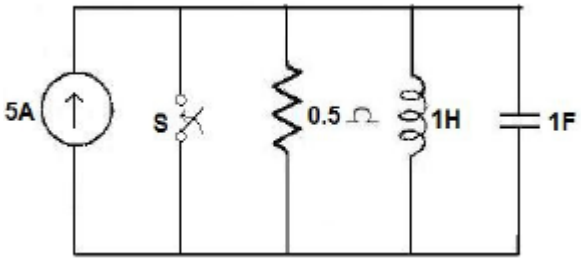
16) Derive an expression for current response of RLC series circuit transient.

17) Derive an expression for current response of RL and RC series circuit transients

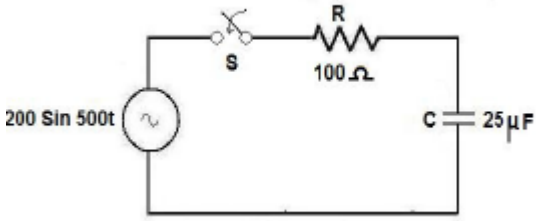
18) A step voltage V(t) = 100 u(t) is applied to a series RLC circuit with L=10H, R=2ohmand C= 5F. The initial current in the circuit is zero but there is an initial voltage of50V on the capacitor in a direction which opposes the applied source. Find theexpression for the current in the circuit.



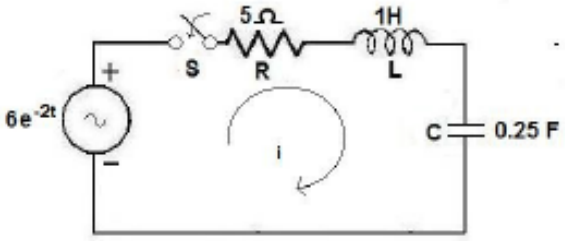

19) For the circuit shown in figure, find the voltage across the resistor 0.5 ohm when theswitch, S is opened at t=0. Assume that there is no charge on the capacitor and no current in the inductor before switching.




20) In the circuit shown in figure, find the current i. Assume that initial charge across the capacitor is zero




21) In the circuit shown in figure, the switch is closed at time t=0. Obtain i(t). Assumezero current through inductor L and zero charge across C before closing the switch.



**Unit No.-IV: Laplace Transform**

**Pre-requisites:**

- Laplace transforms.

**Objectives:**

- To understand the behavior of circuits by analyzing the transient response using Laplace Transform approach.

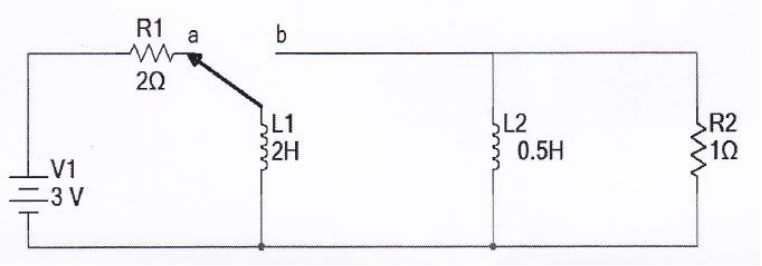
**Outcomes**: After successfully completing this unit students will be able to:

- Students will be able to analyze transient response of basic circuits using Laplace transform.

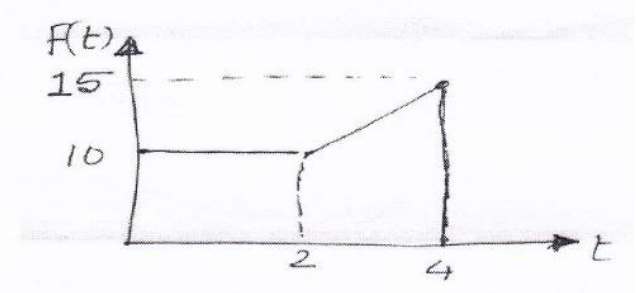
| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| **1** | Basic Properties of Laplace Transform, | T2,T3 R1,R2 | Chalk and Talk |
| **2** | Laplace Transform of Basic R, L and C components, Solutions of differential equations and network equations using Laplace transform method for RL, R-C and R-L-C circuits (series), | T2,T3 R1,R2 | Chalk and Talk |
| **3** | Laplace Transform of Basic R, L and C components, Solutions of differential equations and network equations using Laplace transform method for RL, R-C and R-L-C circuits (parallel), | T2,T3 R1,R2 | Chalk and Talk |
| **4** | Inverse Laplace transforms, | T2,T3 R1,R2 | Chalk and Talk |
| **5** | Transformed networks with initial conditions. theorem | T2,T3 R1,R2 | Chalk and Talk |
| **6** | Analysis of electrical circuits with applications of step, pulse, impulse & ramp functions, shifted & singular functions the convolution integral, application of initial and final value | T2,T3 R1,R2 | Chalk and Talk |

## Question Bank: Theory Unit No.-IV

1) State and explain properties of Laplace Transform.
2) Find the L.T. of the signal $f(t) = \sin \omega t\, u(t)$.
3) State and prove Initial Value Theorem and Final Value Theorem using Laplace transform
4) State and explain standard time signals and their Laplace transform.
5) What do you mean by lap-lace transform pair write its list?
6) State and prove convolution theorem using Laplace transform
7) What do you mean by Inverse Laplace transform.
8) The switch is changed from point a to point b at t= 0. Determine voltage across 4Ω resistance at t = 3sec. Using Laplace Transform.

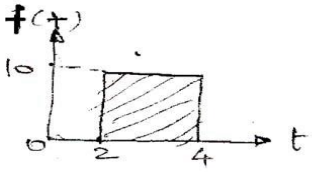



9) Find F(s) for the waveform shown in the figure:

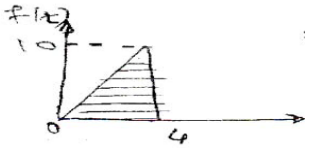



10) Find the Laplace transform of the function whose nature is as shown in figures.

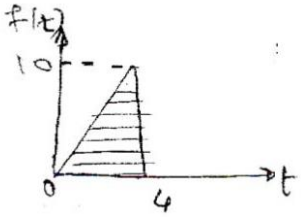
a)




b)




c)



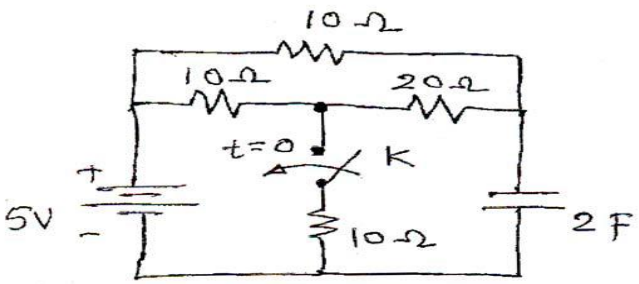

11) Find the inverse Laplace transform of :

a) $$F(s) = \frac{1}{s^3(s^{2-1})}$$

b) $$F(s) = \frac{s+1}{s^3 + 4s^2 + 4s}$$

12) State all the properties of Laplace transform.

13) In the circuit shown in fig 4b, determine Va(0–) and Va(0+) if switch K Is closed:




14) Discuss S-domain networks and their solution using Laplace transform.

15) What are the advantages of Laplace transform solution against classical method?

16) Explain the standard signals.

- Step function
- Ramp function
- Impulse functions

  Also State their Laplace transforms.

## Unit No.-V: Two port network and Filters

**Pre-requisites:**

- Basic Electrical Concepts networks.
- Definition and concept of Electrical circuit Element e.g. Impedance, admittance

**Objectives:**

- To apply knowledge of Network theory for analysis of 2-port networks and design of other circuits like filters

**Outcomes:**

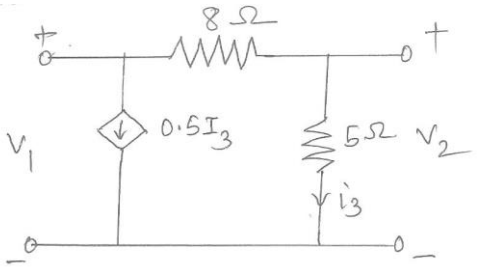
- Students will be able to describe and synthesize two-port network, network functions and identify stability of networks.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Two Port Network: Z, Y, H and transmission parameters, | T2,T3,T4,R3 | Chalk and Talk |
| 2 | Interrelations between parameters. | T2,T3,T4,R3 | Chalk and Talk |
| 3 | Introduction to passive filters, low pass filters, high pass filters | T2,T3,T4,R3 | Chalk and Talk |
| 4 | Introduction to passive filters, low pass filters, high pass filters | T2,T3,T4,R3 | Chalk and Talk |
| 5 | m-derived LPF and HPF filters and design | T2,T3,T4,R3 | Chalk and Talk |
| 6 | m-derived LPF and HPF filters and design | T2,T3,T4,R3 | Chalk and Talk |

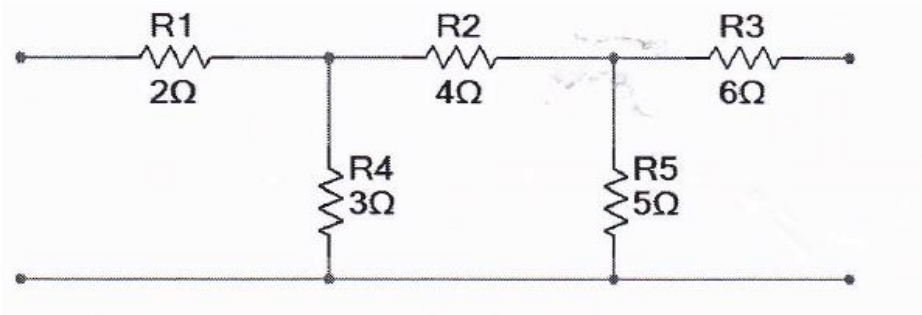
**Question Bank: Theory**

**Unit No.-V**

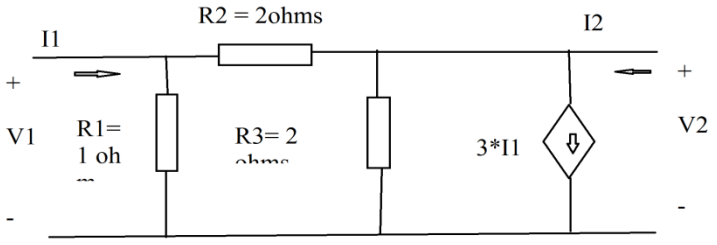
1) Explain the 2-port parameters :
   *(i)* *z*-parameters
   *(ii)* *Y*-Parameters
   *(iii)* *h*-parameters and inverse hybrid parameter.
   *(iv)* T-parameter and inverse transmission parameter
2) Derive the inter-relationship between all above parameters and make a table showing interrelations among all parameter.
3) Explain following connection of two port network parameter
   a) Series connection using Z-parameter
   b) Parallel connection using y-parameter
   c) Cascade connection using T-parameter
   d) Series parallel connection using hybrid parameter
4) Write a short note on insertion loss4. Write a short note on Problems in Optimizing power transfer.
5) A π network has been shown in fig. where ($0.5I_3$) is the controlled Current source. Obtain Z parameters for this π circuit model:




6) Find Z& H parameter of the circuit shown in fig:




7) Find the y and z parameters of the following network:



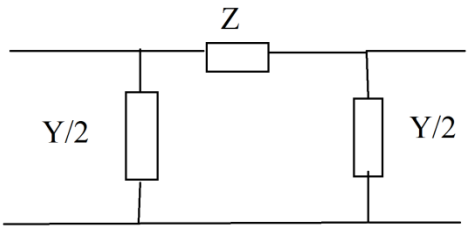

8) A two port network is represented by equations

$V_1 = 24\ I_1 + 8\ I_2$

$V_2 = 8\ I_1 + 32\ I_2$

Find the equivalent network

9) Find ABCD parameters of the given network




10) For the impedance function $Z(s) = \frac{4s^2 + s^2 - 3s + 1}{s^3 + 2s^2 + 2s + 40}$, find the location of poles and zeros.

## Unit No.-VI: Network Functions

**Pre-requisites:**

- Basic Electrical Concepts of filters.

**Objectives**:

- To apply the knowledge in passive filter design.

**Outcomes:** After successfully completing this unit,

- Students will be able to define, recognize and design passive filters.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Poles and Zeros: Terminal pairs or ports, network functions for the one port and two ports, | T2, T3, T4, R1 | PPT |
| 2 | The calculation of network functions, general networks. | T2, T3, T4, R1 | PPT |
| 3 | Poles and zeros of network functions, | T2, T3, T4, R1 | PPT |
| 4 | Restrictions on poles and zeros locations for transfer functions. | T2, T3, T4, R1 | PPT |
| 5 | Driving point function, Time –domain behavior from the pole and zero plot. Stability of active networks | T2, T3, T4, R1 | PPT |
| 6 | Parallel Resonance, Resonance frequency, Quality factor, Current and resonance. | T2, T3, T4, R1 | PPT |

**Question Bank: Theory**

**Unit No.-VI**

1) What is filter? What are general uses of filters?
2) State the classification of filters.
3) State and explain general properties of Filters.
4) Define and explain:
   i. Characteristic Impedance
   ii. Propagation constant
5) Explain:
   i. Constant K filter
   ii. Constant K-Low Pass Filter
   iii. Constant K-High Pass Filter
6) Explain the following terms in relation with filter and give significance of each :
   i. Pass band
   ii. Stop band
   iii. Cut-off frequency
7) Explain High pass and low pass filter with circuit, characteristics and relation for cutoff frequency.
8) What is the difference between prototype filter and m derived filter.
9) Design a RLC band pass filter with a lower frequency of 1 kHZ and a bandwidth of 3 kHz.
10) In a simple section, a low pass filter has a design impedance $R_0$. Find $Z_{0\pi}$ at $0.9f_C$.
11) Design a constant K-low pass filter having cut-off frequency 2.5 kHz and design resistance $R_0$= 700 ohms. Also find the frequency at which this filter produces attenuation of 19.1 dB. Find its characteristic impedances and phase constant at pass band and stop or attenuation band.
12) Design a constant-k low pass filter, the T configuration with cutoff frequency 100 kHz and load 300 Ω
13) Design a constant-k high pass filter, the T configuration with cutoff frequency 100 kHz and load 300 Ω

14) Design a T and π section constant K-high pass filter having cut-off frequency of 12 kHz and nominal impedance $R_0 = 500\Omega$. Also find:
    i. Its characteristic impedance and phase constant at 24 kHz
    ii. Attenuation at 4 kHz
15) Design a constant K-low pass filter having $f_c$=2 kHz and design impedance $R_0$ =600 Ω. Obtain the value of attenuation at 4 kHz

## Practical Assessment

**List of Experiments:**

Any **four** experiments from the first five of the following and any **four** experiments from rest of the list. (Minimum four experiments should be based on simulation software PSPICE/MATLAB along with hardware verification)

| Sr.No. | Name of the Practical |
|---|---|
| **1** | Verification of Superposition theorem in A.C. circuit. |
| **2** | Verification of Thevenin's theorem in A.C. circuits. |
| **3** | Verification of Reciprocity theorem in A.C. circuits. |
| **4** | Verification of Millmans' theorem |
| **5** | Verification of Maximum Power Transfer theorem in A.C. circuits |
| **6** | Determination of time response of R-C circuit to a step D.C. voltage input. (Charging and discharging of a capacitor through a resistor) |
| **7** | Determination of time response of R-L circuit to a step D.C. voltage input. (Rise and decay of current in an inductive circuit) |
| **8** | Determination of time response of R-L-C series circuit to a step D.C. voltage input. |
| **9** | Determination of parameter of Two Port Network |
| **10** | Determination of current under parallel Resonance condition |
| **11** | Determination of Resonance, Bandwidth and Q factor of R-L-C series circuit. |

# Numerical Methods and Computer Programming

# (203148)

**Name of the Subject: Numerical Methods and Computer Programming**

| Weekly Work Load(in Hrs) | Lecture | Tutorial | Practical |
|---|---|---|---|
| | 03 | 00 | 02 |

| Online/ In-Sem | Theory | Practical | Oral | Term-work | Total Marks | Credit |
|---|---|---|---|---|---|---|
| 30 | 70 | 25 | - | - | 125 | 4 |

**Syllabus:**

**Unit 01 : Numerical Computations, Errors and Concept of root of equation (6hrs)**

A) Basic principle of numerical computation. Floating point algebra with normalized floating point technique, Significant digits. Errors: Different types of errors, causes of occurrence and remedies to minimize them, Generalized error formula (Derivation and Numerical) B) Concept of roots of an equation. Descartes' rule of signs, Intermediate value theorem, Roots of Polynomial Equations using Birge-Vieta method.

**Unit 02 : Solution of Transcendental and polynomial equation and Curve Fitting: (6hrs)** A) Solution of Transcendental and polynomial equation using Bisection, Regula- Falsi, Newton-Raphson method for single variable and two variables. B) Curve fitting using least square approximation – First order and second order

**Unit 03 : Interpolation (6hrs)**

Forward, Backward, Central and Divided Difference operators, Introduction to interpolation. A)Interpolation with equal Intervals - Newton's forward, backward interpolation formula (Derivations and numerical), Stirling's and Bessel's central difference formula (Only numericals) B) Interpolation with unequal Intervals- Newton's divided difference formula and Lagrange's interpolation (Derivations and numerical).

**Unit 04 : Numerical Differentiation and Integration (6hrs)**

A) Numerical Differentiation using Newton's forward and backward interpolation formula (Derivation and numerical). B) Numerical Integration: Trapezoidal and Simpson's rules as special cases of Newton-Cote's quadrature technique for single integral. Numerical on double integrals using Trapezoidal and Simpson's 1/3 rd rule.

**Unit 05 : Solution of linear simultaneous equation (6hrs)**

A) Solution of linear simultaneous equation: Direct methods - Gauss elimination method, concept of pivoting – partial and complete. Gauss Jordan method, Iterative methods – Jacobi method and Gauss Seidel method.

B)Matrix Inversion using Gauss Jordan method

**Unit 06 : Solution of Ordinary Differential Equation (ODE) (6hrs)**

A) Solution of First order Ordinary Differential Equation (ODE) using Taylor's series method, Euler's method, Modified Euler's method (Derivation and numerical). Runge-Kutta fourth order method (Numerical). B)Solution of Second order ODE using 4th order Runge-Kutta method (Numerical) Solution of First order Ordinary Differential Equation (ODE) using Taylor's series method, Euler's method, Modified Euler's method (Derivation and numerical). Runge-Kutta fourth order method (Numerical). B)Solution of Second order ODE using 4th order Runge-Kutta method (Numerical)

**List of Experiments:**

Develop computer program using Python language Compulsory Experiments-1,2,3,4,7,10

Any one from 5 or 6 and any one from 8 or 9

1. Develop algorithm, draw flow chart and write a program to implement following:
    a) for loop and while loop-- application in Descarte's rule of sign.
    b) if-else and functions-- application in Intermediate value theorem.
    c) 2DArray formation-- application in matrix data entry, transposition and printing matrix.
2. Develop algorithm, draw flow chart and write a program to implement Birge-Vieta method.

3. Develop algorithm, draw flow chart and write a program to implement Bisection/Regula falsi /Newton- Raphson method (single variable) in following applications (formulate problem statement in any one of following area(but not limited to))
    a) Finding critical clearing angle in power system stability (give equation directly) Relation between voltage and current in solar PV.
4. Develop algorithm, draw flow chart and write a program to implement curve fitting using least square approximation in following applications (formulate problem statement in any one of following area(but not limited to))
    (a) Voltage across capacitor during charging.
    (b) Relate temperature and resistance in thermocouple.
    (c) Current through inductor during excitation.
5. Develop algorithm, draw flow chart and write a program to apply Newton's forward/backward interpolation method in following applications (formulate problem statement in any one of following area(but not limited to))
    (a) Voltage across capacitor during charging
    (b) Relation of speed and armature voltage in DC motor.
    (c) Relation of breakdown voltage and thickness of insulation
6. Develop algorithm, draw flow chart and write a program to apply Newton's divided difference/Lagrange's interpolation method in following applications (formulate problem statement in any one of following area(but not limited to))
    a. Power transfer equation to find power at particular angle
    b. Transformer efficiency at particular loading (data of % loading and efficiency in known at a particular power factor)
    c. Growth of electricity consumption in India (year Vs. Per capita electrical consumption).
7. Develop algorithm, draw flow chart and write a program to implement trapezoidal/ Simpson (1/3)rd rule in following applications (formulate problem statement in any one of following area(but not limited to))
    a) RMS/Average value of given waveform.
    b) Finding current through first order circuit (RL series)
    c) kWh consumption from load curve
    d) Magnetic field intensity in overhead transmission line

8. Develop algorithm, draw flow chart and write a program to implement Gauss elimination/Jordan in following applications (formulate problem statement in any one of following area(but not limited to))

    a. Electrical network using KVL
    b. Electrical Network using KCL

9. Develop algorithm, draw flow chart and write a program to implement Gauss Jacobi/Seidel in following applications (formulate problem statement in any one of following area(but not limited to))
    a) Electrical network using KVL
    b) Electrical Network using KCL

10. Develop algorithm, draw flow chart and write a program to implement Modified Euler's/4th order RK method in following applications (formulate problem statement in any one of following area(but not limited to)
    a. Response of RC series circuit with DC
    b. Response of RL circuit with DC
    c. Deflection angle in MI type instrument

**Text Books:**

[T1] M. K. Jain, S.R.K. Iyangar, R. K. Jain, "Numerical Methods for Scientific and Engineering Computations", New Age Publications.

[T2]Dr. B. S. Grewal, "Numerical Methods in Engineering & Sciences", Khann Publishers.

[T3] P.P. Gupta & G.S Malik, "Calculus of Finite Difference and Numerical Analysis", Krishna Prakashan Media Ltd, Meerut.

[T4] T. Veerarajan and T. Ramchandran, "Numerical Methods with Programs in C and C++", Tata McGraw Hill Publication.

[T5] S Arumugam, "Numerical Methods" Scitech Publication

**Reference Books:**

[R1] J. B. Scarborough, "Numerical Mathematical Analysis", Oxford & IBH, New Delhi.

[R2] Steven Chapra, Raymond P. Canale, "Numerical Methods for Engineers", Tata McGraw Hill Publication.

[R3] S.S. Sastry, "Introductory methods of Numerical Analysis", PHI Learning Private Ltd.

[R4] P. Thangaraj, "Computer oriented Numerical Methods", PHI Learning Private Ltd.

[R5] Yashwant Kanitkar, "Let us Python", pbp publications

[R6] NPTEL course on Numerical Analysis, IIT, Roorkee. https://nptel.ac.in/courses/111107062/

[R7] NPTEL course on MATLAB Programming on Numerical Computation, IIT Madras https://nptel.ac.in/courses/103106118/

[R8] NPTEL course on Python for Data Science, IIT Madras https://nptel.ac.in/courses/106106212/

[R9]Jaan Kiusalaas, "Numerical methods in Engineering with Python", Cambridge University Press

**Course Objective:**

- To emphasize the need of computational techniques and analyze errors involved in the computation.
- To provide sound knowledge of various numerical methods.
- To apply various numerical methods to obtain solution of different types of equations such as transcendental, simultaneous, ODE etc. and also for interpolation, integration and differentiation.
- To impart skills to develop programs using C language.

**Course Outcome:** Upon successful completion of this course, the students will be able to :-

**CO1**: Understand types of errors in computation and their causes of occurrence.

**CO2:** Students will be able to Identify various types of equations and apply appropriate numerical methods to solve transcendental equations and curve fitting techniques.

**CO3:** Students will be able to Apply different numerical methods for solving interpolation numericals

**CO4:** Students will be able to Apply different numerical methods for solving Differentiation and numerical Integration

**CO5:**Students will be able to Apply different numerical methods for solving linear simultaneous equation

## Academic Activity Planner

| Units | Unit Test1 (10marks) | Unit Test2 (10marks) | Assignment No:1 (10marks) | Assignment No:2 (10marks) | OBT : (10marks) | MCQ (10marks) |
|---|---|---|---|---|---|---|
| 1 | ✓ | | | | | |
| 2 | | ✓ | | | | |
| 3 | | | ✓ | | | |
| 4 | | | | ✓ | | |
| 5 | | | | | ✓ | |
| 6 | | | | | | ✓ |

**Teaching Plan:**

**Teaching plan as per University Syllabus**

| Sr.No. | Unit | Broad Topics to be Covered | Total Lecture Planned |
|---|---|---|---|
| 1 | I | Numerical Computations, Errors and Concept of root of equation | 06 |
| 2 | II | Solution of Transcendental and polynomial equation and Curve Fitting: | 06 |
| 3 | III | Interpolation | 06 |
| 4 | IV | Numerical Differentiation and Integration | 06 |
| 5 | V | Solution of linear simultaneous equation | 06 |
| 6 | VI | Solution of Ordinary Differential Equation(ODE) | 06 |

**Unit wise lecture plans**

**Unit No.-I: Numerical Methods , Errors and Concept of root of equation**

**Pre-requisites:-**

- Basic of error and concept of numerical method.

**Objectives:-**

- To emphasize the need of computational techniques and analyze errors involved in the computation

**Outcomes:-** After successfully completing this unit students will be able:

- Demonstrate types of errors in computation and their causes of occurrence

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| **1** | Basic principle of numerical methods. Floating point algebra | R4,R2 ,T6,T1,T3 | Chalk & Talk |
| **2** | Floating point algebra with normalized floating point technique | R4,R2 ,T6,T1,T3 | Chalk & Talk |
| **3** | Significant digits. **Errors**: Different types of errors. | R4,R2 ,T6,T1,T3 | Chalk & Talk |
| **4** | Causes of occurrence and remedies to minimize them. Generalized error formula. | R4,R2 ,T6,T1,T3 | Chalk & Talk |
| **5** | **Concept of roots** of an equation. Descartes' rule of signs | R4,R2 ,T6,T1,T3 | Chalk & Talk |
| **6** | Sturm's theorem | R4,R2 ,T6,T1,T3 | Chalk & Talk |
| **7** | Intermediate value theorem. | R4,R2 ,T6,T1,T3 | Chalk & Talk |
| **8** | Synthetic division, Roots of Polynomial Equations using Birge-Vieta method. | Flip class room Activity | Flip Classroom Activity |
| **9** | Rubrics | | |

**Question Bank: Theory Paper**

1. Using normalized floating point algebra, perform the following arithmetic operations with 4 significant digits

   i. (0.1111E10) X (0.1234E15)

   ii. (0.4546E3) X (0.5454E8)

2. Using Birge vieta method find a real root correct up to three significant decimals of the following equation. :x6 – x4 – x3 -1 = 0, Take initial approx. P0 = 1.5

3. State and explain Descart's rule of sign with example given as

   i. X3 + 2x2 + 10x -20 = 0

4. Explain

   ii. Truncation error

   iii. Relative error

   iv. Absolute error

5.Write a note on Sturm's theorem and intermediate value theorem

## Unit No.-II: SOLUTION OF TRANSCENDENTAL AND POLYNOMIAL EQUATION AND CURVE FITTING

**Pre-requisites :-**

- Basic concepts of polynomial equation and concept of root.

**Objectives :-**

- To apply various numerical methods to obtain solution of different types of equations such as transcendental **,** polynomial equation and to impart skills to develop programs using C language.

**Outcomes:** After successfully completing this unit students will be able to:

- Identify various types of equations and apply appropriate numerical method to solve different equations

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| **1** | **Solution of Transcendental and polynomial equation:** Bisection method. | T2,T3,T4, R2 | Flip Classroom Activity |
| **2** | Secant Method, Regula-Falsi Method | T2,T3,T4, R2 | Chalk & talk |
| **3** | Newton-Raphson methods Chebyeshev Method | T2,T3,T4, R2 | Chalk & talk |
| **4** | Newton-Raphson method for two variables Method | T2,T3,T4, R2 | Chalk & talk |
| **5** | **Curve Fitting** using least square approximation – First order and second order. | T2,T3,T4, R2 | Chalk & talk |
| **6** | Numerical practice , Rubrics | T2,T3,T4, R2 | Flip Classroom Activity |

## Question Bank: Theory

### Theory Paper

1. What is mean by curve fitting?
2. Explain 1st order and 2nd order least square approximation.
3. Explain the Chebyshev method.The current is particular circuit is given by $I^3 - 5I - 7 = 0$.
4. Find the value of current using bisection & Regula falsi method, correct upto 3 decimal places.
5. Find the smallest positive root of x3 - 5x + 3 = 0 using N-R method using 4 iterations.
6. Use secant method to determine the root of following equation:
   $f(x) = \cos x - xe^x = 0$. Find the root up to 3 decimal places.
7. Explain the N-R two variable method.

## Unit No.-III: INTERPOLATION

**Pre-requisites:-**

- Linear Algebra.

**Objectives:-**

- To provide sound knowledge of various numerical methods.
- To apply various numerical methods to obtain solution of different types of Interpolation and Numerical Differentiation

**Outcomes:** After successfully completing this unit students will be able to:

- Apply different numerical methods for interpolation, differentiation.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| **1** | **Interpolation:** Difference operators | T2,T3,T4, R2 | Flip Classroom Activity |
| **2** | Introduction to interpolation - Newton's forward interpolation formulae | T2,T3,T4, R2 | Flip Classroom Activity |
| **3** | Newton's backward interpolation formulae | T2,T3,T4, R2 | Flip Classroom Activity |
| **4** | Sterling's and Bessel's central difference formulae | T2,T3,T4, R2 | Flip Classroom Activity |
| **5** | Newton's divided difference formula | T2,T3,T4, R2 | Flip Classroom Activity |
| **6** | Lagrange's interpolation | T2,T3,T4, R2 | Flip Classroom Activity |
| **9** | Rubrics | | |

## Question Bank: Theory

### Theory Paper

1) Following table gives relation between x and y. Determine y(3.5) and y(8.5) using appropriate interpolation formula.

| X | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|
| Y | 4.8 | 8.4 | 14.5 | 23.6 | 36.2 | 52.8 | 73.9 |

2) Use Newton's divided difference interpolation formula to evaluate f(3) from the following table

| X | 0 | 1 | 2 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| F(x) | 1 | 14 | 15 | 5 | 6 | 19 |

3) Derive the Sterling's and Bessel's central difference formula.

4) From the following table of values of x and y obtain (dy/dx) and ($d^2y/dx^2$) for x=1.2 and x=2.

| X | 1 | 1.2 | 1.4 | 1.6 | 1.8 | 2 | 2.2 |
|---|---|---|---|---|---|---|---|
| Y | 2.7183 | 3.3201 | 4.0552 | 4.9530 | 6.0496 | 7.3891 | 9.0250 |

5) Write a note on Newton's forward and backward interpolation method.

6) Explain in detail Newton's divided difference method.

## Unit No.-IV: Numerical Differentiation and Integration

**Pre-requisites:-**

- Concept of ordinary differential equations.

**Objectives:-**

- To apply various numerical methods to obtain solution of different types of equations such ODE

**Outcomes:-**After successfully completing this unit students will be able to:

- Apply and compare various numerical methods to solve first and second order ODE.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | **Numerical Differentiation** using using Newton's forward interpolation formula (Derivation and numerical). | T2,T3,T4, R2 | Chalk & talk |
| 2 | **Numerical Differentiation** using backward interpolation formula (Derivation and numerical). | T2,T3,T4, R2 | Chalk & talk |
| 3 | **Numerical Integration:** Trapezoidal and | T2,T3,T4, R2 | Flip Classroom Activity |
| 4 | Simpson's rules as special cases of Newton-Cote's quadrature technique for single and double integrals. | T2,T3,T4, R2 | Chalk & talk |
| 5 | Numerical on double integrals using Trapezoidal rule. | T2,T3,T4, R2 | |
| 6 | Numerical on double integrals using Simpson's 1/3 rd rule. | T2,T3,T4, R2 | |
| 9 | Rubrics | | |

## Question Bank: Theory

### Theory Paper

1) Use Simpson's 1/3rd rule and trapezoidal rule to evaluate $\int_0^{12} \log(1 + x * x)dx$

$\int_0^{12} \log(1 + x * x)dx$ by taking suitable number of intervals.

2) Write a note on R-K method.

3) Apply Euler's method to solve $y' = -xy^2$, y (0) =2. Compute up to x=1 with h=0.1

4) Solve the following equations

$d^2y/dx^2 = x\,(dy/dx) - y$

## UNIT NO.-V

## SOLUTION OF LINEAR SIMULTANEOUS EQUATION

**Pre-requisites:-**

- Basic concept of simultaneous equations

**Objectives: -**

- To impart skills to develop programs using C language.
- To provide sound knowledge of various numerical methods.

**Outcomes:-**After successfully completing this unit, students will be able to:

- Apply and compare various numerical methods to solve linear simultaneous equations

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | **Solution of simultaneous equation:** Direct methods - Gauss elimination Mathod | T2,T3,T4, R2 | Chalk & talk |
| 2 | Gauss-Jordan methods | T2,T3,T4, R2 | Chalk & talk |
| 3 | concept of pivoting – partial and complete | T2,T3,T4, R2 | Chalk & talk |
| 4 | Iterative methods – Jacobi Method | T2,T3,T4, R2 | Chalk & talk |
| 5 | Gauss Seidel method | T2,T3,T4, R2 | Flip Classroom Activity |
| 6 | **Matrix Inversion** using Jordon method | T2,T3,T4, R2 | Chalk & talk |
| 7 | Eigen values using Power method | T2,T3,T4, R2 | Flip Classroom Activity |
| 8 | Numericals | T2,T3,T4, R2 | Chalk & talk |
| 9 | Rubrics | | |

**Question Bank: Theory**

**Theory Paper**

1. Solve the following system of equations using Gauss elimination method
   i. 2x+y-0.1z+t=2.7
   ii. 0.4x+0.5y+4z-8.5t=21.9
   iii. 0.3x-y+z+5.2t= -3.9
   iv. X+0.2y+2.5z-t=9.9
2. Solve the following system of equations using Gauss Jordon method
   i. 2x1+x2+2x3+x4=6
   ii. 6x1-6x2+6x3+12x4=36
   iii. 4x1+3x2+3x3-3x4= -1
   iv. 2x1+2x2-x3+x4=10
3. Write a note on Gauss Seidel iterative method.
4. Write a note on Jacobi method of symmetric matrices for finding eigen values and eigen vectors.
5. Explain Gauss Jordon method.
6. Write a note on Gauss elimination method.
7. Explain: Partial pivoting.

## UNIT NO.-VI

## Solution of Ordinary Differential Equation(ODE)

**Pre-requisites:-**

Basic concept of differential equations

**Objective**s: - To impart skills to develop programs using C language.

To provide sound knowledge of various numerical methods.

**Outcomes:-**After successfully completing this unit, students will be able to:

Apply and compare various numerical methods to solve linear simultaneous equations

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| **1** | Solution of First order Ordinary Differential Equation: using Taylor's series method | T2,T3,T4, R2 | Chalk & talk |
| **2** | Euler's method, | T2,T3,T4, R2 | Chalk & talk |
| **3** | Modified Euler's method (Derivation and numerical). | T2,T3,T4, R2 | Chalk & talk |
| **4** | Runge-Kutta fourth order method (Numerical) | T2,T3,T4, R2 | Chalk & talk |
| **5** | Solution of Second order ODE using 4th order Runge-Kutta method :Derivation | T2,T3,T4, R2 | Flip Classroom Activity |
| **6** | Solution of Second order ODE using 4th order Runge-Kutta method (Numerical) | T2,T3,T4, R2 | Chalk & talk |
| **9** | Rubrics | | |

**Question Bank: Theory**

**Theory Paper**

1. Using Taylor series method of order four solve the initial value problem y' = (x - y)/2, on [0, 3] with y(0) = 1. Compare solutions for h = 1, 1/2, 1/4 and 1/8.
2. Using Taylor series method, find y(0.1) for $y' = x - y^2$, y(0) = 1 correct upto four decimal places.
3. Find y at x = 1.1 and 1.2 by solving $y' = x^2 + y^2$, y(1) = 2.3
4. Find y(0.5) if y is the solution of IVP y' = -2x-y, y(0) = -1 using Euler's method with step length 0.1. Also find the error in the approximation.
5. Use Euler's method to solve for y[0.1] from y' = x + y + xy, y(0) = 1 with h = 0.01 also estimate how small h would need to obtain four decimal accuracy.
6. Solve the differential equation y' = x/y, y(0)=1 by Euler's method to get y(1). Use the step lengths h = 0.1 and 0.2 and compare the results with the analytical solution ($y^2 = 1 + x^2$)
7. Using Euler's method find the approximate solution of y' = (y - x)/(y + x), y(0) = 1.0 at x = 0.1 by taking h = 0.02
8. Find y(0.8) with h = 0.1 from y' = y - 2x/y, y(0) = 1 using Euler's method
9. Find y(1.0) using RK method of order four by solving the IVP $y' = -2xy^2$, y(0) = 1 with step length 0.2. Also compare the solution obtained with RK methods of order three and two.
10. Find y in [0,3] by solving the initial value problem y' = (x - y)/2, y(0) = 1 using RK method of order four with h = 1/2 and 1/4.
11. Using RK method of order four find y(0.1) for $y' = x - y^2$, y(0) = 1.
12. Using RK method of order four find y at x = 1.1 and 1.2 by solving $y' = x^2 + y^2$, y(1) = 2.3

## List of Experiments

Develop computer program using Python language Compulsory Experiments-1,2,3,4,7,10
Any one from 5 or 6 and any one from 8 or 9

1. Develop algorithm, draw flow chart and write a program to implement following:

(a) for loop and while loop-- application in Descarte's rule of sign.

(b) if-else and functions-- application in Intermediate value theorem.

(c) 2DArray formation-- application in matrix data entry, transposition and printing matrix.

2. Develop algorithm, draw flow chart and write a program to implement Birge-Vieta method.

3. Develop algorithm, draw flow chart and write a program to implement Bisection/Regula falsi /Newton- Raphson method (single variable) in following applications (formulate problem statement in any one of following area(but not limited to))

(a) Finding critical clearing angle in power system stability (give equation directly)

(b) Relation between voltage and current in solar PV.

4. Develop algorithm, draw flow chart and write a program to implement curve fitting using least square approximation in following applications (formulate problem statement in any one of following area(but not limited to))

(a) Voltage across capacitor during charging.

(b) Relate temperature and resistance in thermocouple.

(c) Current through inductor during excitation.

5. Develop algorithm, draw flow chart and write a program to apply Newton's forward/backward interpolation method in following applications (formulate problem statement in any one of following area(but not limited to))

(a) Voltage across capacitor during charging

(b) Relation of speed and armature voltage in DC motor.

(c) Relation of breakdown voltage and thickness of insulation

6. Develop algorithm, draw flow chart and write a program to apply Newton's divided difference/Lagrange's interpolation method in following applications (formulate problem statement in any one of following area(but not limited to))

(a) Power transfer equation to find power at particular angle

(b) Transformer efficiency at particular loading (data of % loading and efficiency in known at a particular power factor)

(c) Growth of electricity consumption in India (year Vs. Per capita electrical consumption).

7. Develop algorithm, draw flow chart and write a program to implement trapezoidal/ Simpson (1/3)rd rule in following applications (formulate problem statement in any one of following area(but not limited to))

(a) RMS/Average value of given waveform.

(b) Finding current through first order circuit (RL series)

(c) kWh consumption from load curve

(d) Magnetic field intensity in overhead transmission line

8. Develop algorithm, draw flow chart and write a program to implement Gauss elimination/Jordan in following applications (formulate problem statement in any one of following area(but not limited to))

(a) Electrical network using KVL

(b) Electrical Network using KCL

9. Develop algorithm, draw flow chart and write a program to implement Gauss Jacobi/Seidel in following applications (formulate problem statement in any one of following area(but not limited to))

(a) Electrical network using KVL

(b) Electrical Network using KCL

10. Develop algorithm, draw flow chart and write a program to implement Modified Euler's/4th order RK method in following applications (formulate problem statement in any one of following area(but not limited to)

(a) Response of RC series circuit with DC

(b) Response of RL circuit with DC

(c) Deflection angle in MI type instrument

**Practical Assessment**

1 .Student Log Book

1. Date
2. Exp. No.
3. Aim/Title
4. Program
5. No. of iterations
6. Numerical Solving
7. Comparison of theoretical calculations and Program outcome
8. Conclusion

2. Continuous Assessment (ARB)

# Fundamental of Microcontroller and Applications
# (203149)

**Name of the Subject –Fundamentals of Microcontroller and Applications**

**Syllabus**

| Weekly Work Load(in Hrs) | Lecture | Tutorial | Practical |
|---|---|---|---|
| | 03 | 00 | 04 |

| Online/ In-Sem | Theory | Practical | Oral | Term-work | Total Marks | Credit |
|---|---|---|---|---|---|---|
| 30 | 70 | - | 25 | 25 | 125 | 5 |

**Prerequisite:**

Knowledge of numbering systems and Boolean algebra.

Knowledge of combinational and sequential logic circuits.

**Course Objective:**

Objectives of the course are to

- Explain the microcontroller architecture & describe the features of a typical microcontroller.
- To use the 8051 addressing modes and instruction set and apply this knowledge to develop programs in assembly language and C language.
- To define the protocol for serial communication and understand the microcontroller development systems.
- Explain the interrupt structure of the microcontroller and to develop programs related to interrupt handling
- To introduce students to Global System for Mobile Communication (GSM)
- To provide students with interfacing concepts and develop interfacing circuits for simple devices.

**Unit 01 : (6 Hrs)**

Introduction to concept of microcontroller, Intel 8051 Functional block diagram, Functions of pins of 8051, Memory organization of 8051, PSW and Flag Bits, Stack and Stack pointer. Overview of special function registers,Data transfer instructions and programs in assembly language.

**Unit 02 :** **(6 Hrs)**

Arithmetic and logical instructions and programs in assembly language. Boolean and Program Branching instructions and programs in assembly language. Addressing modes of 8051.

**Unit 03 :** **(6 Hrs)**

8051 Programming in C , Data types in C . Ports of 8051, their use, and programming in C (Byte Level and Bit-level). Time delay programming in C. Timers and counters in 8051, Timer modes 0,1,2 and its programming in C and counterprogramming.

**Unit 04 :** **(6 Hrs)**

Interrupt structure of 8051 and SFR associated with interrupts Programming of External hardware interrupts in C. Interfacing of ADC 0809 with 8051.

**Unit 05 : (6 Hrs)**

Serial port Structure in 8051. Programming of Serial port for transferring and receiving data in C in mode 1. Introduction to GSM module, AT commands, Programming to send and read SMS.

**Unit 06 :** **(6 Hrs)**

Measurement of electrical parameters such as voltage, current (Theoretical Treatment only). Interfacing of Stepper motor with 8051 and its programming in C. Interfacing and programming of single Key, LED, and Relay with 8051 in C.

**Guidelines for Instructor's Manual**

1. Commands to be followed to operate the 8051 microcontroller kit.
2. The architecture of the 8051 microcontroller kit-Functional block diagram & its explanation.

3.Pin Diagram of 8051 microcontrollers with a description of all the 40 pins.
4. Addressing modes-Explanation with an example.
5. Instruction set for Data transfer, Arithmetic, Logical, Branching & Bit manipulation along with an explanation.
6. User manuals of all the interfacing kits such as stepper motor, DC motor, DAC, ADC &LED.

**Guidelines for Student's Lab Journal**

1. Title of the program.
2. The program has to be written in the following format. Address- Instruction- Comment
3. Input data has to be specified.

4. Result of the program.

5. Flow Chart for each program has to be drawn on a separate page.

**Guidelines for Laboratory Conduction**

1. Each group in the lab should have not more than three students.

2. Each student within the group has to enter and execute the program turn wise.

3. A faculty member has to check the result of all the groups after the execution of the program.

**List of Experiments:**

**PART A: [TW: 15 Marks]**

Compulsory Experiments:

1. Study and use of 8051 Microcontroller trainer kit.

2. Assembly Language Program for the arithmetic operation of 8-bit numbers.

3. Assembly Language Program for finding the largest number and smallest number from a given an array of 8-bit numbers.

4. Assembly Language program to arrange 8-bit numbers stored in an array in ascending order and descending order.

**Any four experiments are to be conducted of the following experiments using embedded C :**

1. Implementation of Serial Communication by using 8051 serial ports.

2. Programming using a cross-assembler.

3. The blinking display of LED's interfaced with 8051.

4. Interfacing of 8 bit DAC 0808 with 8051 to generate various waveforms.

5. Interfacing of 8 bit ADC 0809 with 8051 Microcontroller.

6. Interfacing of the relay with 8051.

7. Stepper motor control by 8051 Microcontroller.

8. Interfacing of matrix keyboard/ 7 segment display with 8051.

9. Interfacing of LCD with 8051.

**PART B: [TW: 10 Marks]**

**Prerequisite:** Programming exercises of C language.

**Compulsory Experiments:**

1. Study of GSM Module SIM800/SIM900/QUECTEL M95 and AT Commands

2. Study of IoT system

3. Interfacing of GSM with a computer through COM port to Send and Receive SMS.

4. Interfacing GSM with 8051 trainer kit and develop a program to send AT commands.

Any two experiments are to be conducted of the following experiments:

1.Develop a program in C to read and send SMS from the GSM module.

2.Measurement of physical parameters (Temperature/Pressure/Humidity) using 8051 and send value to GSM after an interval of the specified interval.

3.Measurement of electrical parameters (Voltage/Current) using 8051 and send value to the GSM module after an interval of 10min.

4. Develop a program to turn on and turn off induction Motor using 8051 and GSM module.

5. Development of mobile app for various applications in electrical engineering.

**Text Books:**

[T1] Muhammad Ali Mazidi, J.G. Mazidi, "The 8051 Microcontroller and Embedded Systems", Pearsons Publishers.

[T2] V Udayashankara and M S MallikarjunaSwamy, "8051 Microcontroller, Hardware, software and applications", TATA McGraw Hill.

[T3] Ajay Deshmukh, "Microcontroller 8051" –TATA McGraw Hill.

[T4] Theagrajan," Microprocessor and Microcontroller", BS Publication.

[T5] K. J. Ayala, "The 8051 Microcontrollers- Architecture, Programming and Applications", Peram International Publications.

[T6] SubrataGhoshal, "8051 microcontroller", Pearsons Publishers.

[T7] Han-Way Huang," Embedded System Design with C8051", Cengage Learning

**Reference Books:**

[R1] Scott Mackenzie, "8051 Microcontroller", Pearson Education.

[R2] Intel Microcontroller data book.

[R3] Intel Corporation 1990- 8 bit embedded controller handbook

**Publication.IS/IEEE Standards:**

**Reference Web Links/ Research Paper/ Referred Book other than Mention in Syllabus:**

1. http://nptel.ac.in

2.http://freevideolectures.com/Course/3018/Microprocessors-and-Microcontrollers/29**[IIT Kharagpur Course , Prof. Ajit Pal]**

3.http://www.keil.com/dd/docs/datashts/intel/80xxah_ds.pdf

**Course Outcomes:**

**Theory:**

**CO1:** Students will be able to describe the architecture and features of various types of the microcontroller.

**CO2:** Student will be able to illustrate addressing modes and execute programs in assembly language for the microcontroller.

**CO3:** Students will be to apply knowledge of writing programs in C language for microcontroller 8051.

**CO4:** Student will be able to study interrupt structure of 8051 and apply program to handle interrupt and ADC809

**CO5:** Student will be able to explain protocol for serial communication and microcontroller development systems.

**CO6:** Students will be able to Interface input output devices and measure electrical parameters with 8051 in real time.

**Practical**

**CO1:** Students will be able to demonstrate 8051 Microcontroller trainer kit

**CO2:** Students will be able to develop programs using embedded C and ALP in 8051 microcontroller

**CO3:** Students will be able to illustrate how the different peripherals are interfaced with Microcontroller

**CO4:** Students will be able to use the interfacing circuits for various applications of 8051 microcontroller.

## Academic Activity Planner

| Units | Unit Test1 (10marks) | Unit Test2 (10marks) | Assignment No:1 (10marks) | Assignment No:2 (10marks) | OBT : (10marks) | MCQ (10marks) |
|---|---|---|---|---|---|---|
| 1 | ✓ | | | | | |
| 2 | | ✓ | | | | |
| 3 | | | ✓ | | | |
| 4 | | | | ✓ | | |
| 5 | | | | | ✓ | |
| 6 | | | | | | ✓ |

**Teaching plan as per University Syllabus**

| Sr.No. | Unit | Broad Topics to be Covered | Total Lecture Planned |
|---|---|---|---|
| 1 | I | 8051 Architecture | 6 |
| 2 | II | Assembly language Programming | 6 |
| 3 | III | Programming of 8051 microcontroller in C | 6 |
| 4 | IV | Interrupt programming | 6 |
| 5 | V | Serial Communication and Special Hardware features and Programming | 6 |
| 6 | VI | Interfacing of 8051 Microcontroller for practical application | 6 |

## Lecture Plan

## Unit No.-I

**Pre-requisites:-**

- Basic concepts of Micro Controllers

**Objectives:-**

- To understand difference between microprocessor and microcontroller.
- To understand different types of microcontrollers, 8051 architecture, pin diagram.
- To study the concept of interfacing and operation of Input output ports.

**Outcomes:** Student can

- Differentiate between microprocessor and microcontroller.
- Describe the architecture and features of various types of microcontroller.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Introduction to concept of microcontroller, comparison of Microprocessor and microcontroller, difference between CISC RISC, Difference between Von Neumann and Harvard architecture, Comparison of all 8 bit microcontrollers. | T1,T2,T3,T4 R1,R2,R3,R4 | PPT |
| 2 | Description for Intel 8051 microcontroller architecture, Pin diagram. | | PPT |
| 3 | How to find address range for the given memory range, Memory organization of 8051-RAM Organization. | | PPT |
| 4 | PSW and Flag Bits, Stack and Stack pointer | | PPT |
| 5 | Overview of special function registers | | PPT |
| 6 | Data transfer instructions and programs in assembly language | | PPT |
| 7 | programs in assembly language | | |

**Question Bank: Theory- Unit: I**

1. What is the size of the internal RAM memory of the 8051?
2. The 8051 has _____ 16-bit counter/timers.5.
3. Name 2 register that consists of 16 bit.
4. What are SFR?
5. List all the registers used in 8051 microcontroller in brief.
6. Draw the memory organization of mcs – 51.
7. What are all addressing modes of mcs-51?
8. Enlist the various flags in the PSW register.
9. Draw the block diagram of 8051 microcontroller.
10. How many I/O ports are placed in microcontroller 8051?
11. What is use of EA pin?
12. How many bit addressable location are placed in internal RAM?
13. List the features of the 8051 microcontrollers
14. What is PSW?
15. What are addressing modes? Give the addressing modes of 8051

## Unit No.-II:

**Pre-requisites:-**

- Basics of numbering system.

**Objectives:-**

- To use the 8051 addressing modes and instruction set and apply this knowledge to perform programs - arithmetic & logic operations, data & control transfer operations, input & output operations.

**Outcomes:-**

After successfully completing this unit students will be able:

- Student will be able to illustrate addressing modes and execute programs in assembly language for the microcontroller.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Different types of Addressing modes in 8051 with example. | T1,T2,T3,T4 R1,R2,R3,R4 | PPT |
| 2 | Instructions set explanation with addressing modes with no. bytes taken by instruction | | PPT |
| 3 | Arithmetic instructions and programs in assembly language. | | PPT |
| 4 | Logical instructions and programs in assembly language. | | PPT |
| 5 | Boolean instructions and programs in assembly language. | | PPT |
| 6 | Branching instructions and programs in assembly language. | | PPT |

## Question Bank: Theory

1. Mention any two examples of direct addressing instructions?
2. What are all addressing modes of mcs-51?
3. Define stack, stack pointer and their operation for mcs-8051.
4. Define SWAP and Rotate instruction
5. Define call and return subroutine.
6. What is the operation carried out when 8051 executes the instruction : MOVC A, @A+DPTR?
7. Load 42h and 55H in register R0 and R1 respectively.
8. Load 45H in external memory location 8000H.Write program instructions to load a byte in memory location 9000H and increment the contents of the memory location
9. Explain following instructions.
   [1] XCHD A, R1
   [2] MOVC A,@A+DPTR
   [3] MOV A, 50H
   [4] MOV R7,#50H
   [5] MOV 50H ,#50H
10. Explain following instructions
    [1] SWAP A
    [2] MOVX A,@DPTR
    [3] DIV AB
    [4] MUL AB
    [5] RR A

## Unit No.-III

**Pre-requisites:-**

- To use the 8051 addressing modes and instruction set and apply this knowledge to develop programs in assembly language and C language.

**Objectives:-**

- To use the 8051 addressing modes and instruction set and apply this knowledge to develop programs in assembly language and C language.

**Outcomes:-**

After successfully completing this unit students will be able to:

- Apply knowledge of writing programs in C language for microcontroller 8051.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Syntax of C, 8051 Programming in C | T2, T5, R2 | PPT |
| 2 | Data types in C. Ports of 8051, I/O port structure and working of I/O ports | | PPT |
| 3 | Use of ports there alternate functions and programming in C | | PPT |
| 4 | Byte Level and Bit-level. Time delay programming in C | | PPT |
| 5 | Timers and counters in 8051, Timer modes 0 and its programming in C and counter programming. | | PPT |
| 6 | Timer modes 1 and its programming in C and counter programming. | | PPT |
| 7 | Timer modes 2 and its programming in C and counter programming. | | PPT |

## Question Bank

1. Define Timers and Counters in 8051.
2. Define modes of Timer.
3. Write a brief note on I/O port configuration in 8051.
4. Write a brief note on timers in 8051.
5. Explain the TMOD function register and its timer modes of operations.
6. Explain the operating mode2 of 8051 serial ports?
7. Explain the mode3 of 8051 serial ports?
8. What is the maximum delay the Timer0 produces when 8051 is operated at 12MHz?
9. Find the value of TH1 if the timer1 is used in timer mode2 to generate a baud rate of 4800. Assume appropriate oscillator frequency.
10. Draw and explain time/counter logic diagram for 8051 microcontroller. Write a program to generate square wave of frequency 1Kz on pin 1.2

**Unit No.-IV**

**Pre-requisites:-**

- To use the 8051 addressing modes and instruction set and apply this knowledge to develop programs in assembly language and C language.

**Objectives:-**

- To use the 8051 addressing modes and instruction set and apply this knowledge to develop programs in assembly language and C language.

**Outcomes:-**

After successfully completing this unit students will be able to:

- Apply knowledge of writing programs in C language for microcontroller 8051.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Interrupt structure of 8051 difference between interrupt and polling, various types of interrupt sources and their priority and vector address. | T2, T5, R2 | PPT |
| 2 | Steps in Executing an Interrupt | | PPT |
| 3 | IP, IE registers and its explanation. | | PPT |
| 4 | Enabling and Disabling an Interrupt | | PPT |
| 5 | External Hardware Interrupt Programming | | PPT |
| 6 | 8 bit ADC Interfacing of ADC 0809 with 8051. | | PPT |
| 7 | Interfacing of ADC 0809 with 8051 and its Programming of ADC 0809 with 8051 | | PPT |

## Question Bank

1. Explain the different serial communication modes in 8051.
2. Explain SBUF register of 8051.
3. Describe the baud rate in UART 8051. On which factors it depends.
4. Explain the operating modes of serial port of IC 8051 microcontroller.
5. Draw & explain PCON register format of 8051.
6. Draw the format of SCON register & explain the function of each bit.
7. Write a program for serial port of 8051 to transfer letter “A" serially at 4800 baud rate continuously
8. Explain 8051 provides 5 vectored interrupts. And define its priority.
9. Explain interrupt register associated to timer, External Hardware Interrupt, Serial Communication Interrupt.
10. With neat diagram explain the ADC interface to 8051.

## Unit No.-V

**Pre-requisites:-**

- Knowledge of combinational and sequential logic circuits, use the 8051 addressing modes and instruction set and apply this knowledge to develop programs in assembly language and C language.

**Objectives:-**

- Explain the interrupt structure of the microcontroller and to develop programs related to interrupt handling
- To introduce students to Global System for Mobile Communication (GSM)

**Outcomes:-** After successfully completing this unit students will be able to:

- Student will be able to explain protocol for serial communication and microcontroller development systems.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Basic Of Serial Communication and Structure of Serial Port. | T2, T5, R2 | PPT |
| 2 | Serial communication, difference between serial and parallel communication, framing, and registers related to serial communication SBUF, SCON, SMOD bit. | | PPT |
| 3 | Programming of serial port for transferring and receiving data in C in mode 1. | | PPT |
| 4 | Modes of serial communications, baud rate calculation of thx (count) for different mode rates, interfacing of 8051 with pc through rs232 | | PPT |
| 5 | Programming serial data transmission and reception | | PPT |
| 6 | Introduction to GSM module, at commands, | | PPT |
| 7 | Programming to send and read SMS. | | PPT |

## Question Bank

1. Compare Interrupt And Polling. (Any Two Points)
2. Draw The Format Of SBUF Register With Its Use In Microcontroller.
3. Draw The Format Of PCON Register.
4) Draw The Format Of SCON Register And Describe Each Bit.
5) Describe Serial Communication Modes.(Any Two Are Asked In Exam)
6) Write A Program For Serial Port Of 8051 To Transfer Letter “A” Serially At 4800 Baud Rate Continuously.
7) Write A Program To Send Message “WELCOME” Serially At 9600 Baud Rate Continuously.
8) Write An Assembly Language Program For 8051 To Receive 10 Bytes Of Data Serially And Save Them In Accumulator. Assume Baud Rate Is 4800, 8 Bit Data, 1 Stop Bit.
9) Describe All I/O Port Structure Of 8051 With Neat Diagram. (Any Two Are Asked)
10) List Interrupts Of 8051 Microcontroller With Their Vector Addresses And Priorities

## Unit No.-VI

**Pre-requisites:-**

- Knowledge of combinational and sequential logic circuits, use the 8051 addressing modes and instruction set and apply this knowledge to develop programs in assembly language and C language.

**Objectives:-**

- Explain the interrupt structure of the microcontroller and to develop programs related to interrupt handling
- To introduce students to Global System for Mobile Communication (GSM)

**Outcomes:-**After successfully completing this unit students will be able to:

- To provide students with interfacing concepts and develop interfacing circuits for simple devices.

| Lecture No. | Details of the Topic to be covered | References | Mode of Delivery |
|---|---|---|---|
| 1 | Measurement of electrical parameters such as voltage, current (Theoretical Treatment only). | T2, T5, R2 | PPT |
| 2 | Interfacing of 8051 with single key, LED. | | PPT |
| 3 | Programming Interfacing of 8051 with single key, LED, | | PPT |
| 4 | Interfacing of 8051 and Relay with 8051 in C. | | PPT |
| 5 | Interfacing of Stepper motor with 8051 and its programming in C | | PPT |
| 6 | Revision | | PPT |

## Question Bank

1. Explain Interfacing of 8051 with single key, LED, Relay, voltage, current, speed control of dc motors, Stepper motor control (speed /position).
2. Programming to control DC and Stepper motor.
3. Explain LM35 and it interfacing with 8051.
4. Draw interfacing of LED with 8051 microcontroller.