7. SUBJECT DETAILS

7.6 ELECTRICAL DISTRUBUTION SYSTEMS

7.6.1 Objectives and Relevance

7.6.2 Scope

7.6.3 Prerequisites

7.6.4 Syllabus

i. JNTU

ii. GATE

iii. IES

7.6.5 Suggested Books

7.6.6 Websites

7.6.7 Experts' Details

7.6.8 Journals

7.6.9 Finding and Development

7.6.10 i. Session Plan

ii. Tutorial Plan

7.6.11 Student Seminar Topics

7.6.11 Question Bank

i. JNTU

ii. GATE

iii. IES

7.6.1 OBJECTIVE AND RELEVANCE:

Electrical distribution is one of the most important wings in Electrical Power Industry. For most efficient reliable and interrupted electrical power supply, proper planning and protection in distribution of electrical power is important.

It deals with supply of electrical energy from main stations till the customer premises and deals with both low voltage (less than 1000V) and medium voltage (1000V to 33kV) of three phase AC and other special systems like 1500V or 3000V DC or 25kV AC traction systems etc. Supply of electric power to consumers is ensured by an efficient distribution system. However failures in the system effect the customer. In India about 90% of consumer interruptions are attributed to distribution systems and losses vary upto 75% of the overall system losses.

Electric power distribution has been specially designed to deal with problems related to the rapidly expanding distribution systems, load management & reduction of distribution system losses.

7.6.2 SCOPE

This subject enables students to elaborate in great detail the methodology for forecasting load and energy requirement based on statical econometrix models. It also deals with few methods to improve the quality of power supply and to protect the system under faults.

7.6.3 PREREQUISITES

A basic knowledge on these subjects would be beneficiary
(i) Power Systems-I,
(ii) Switchgear & Protection

7.6.4.1 JNTU SYLLABUS

UNIT-I
OBJECTIVE
This unit gives a comprehensive idea regarding the general concepts of the distribution systems and load modelling.

SYLLABUS
GENERAL CONCEPTS: Introduction to distribution systems, Load modelling and characteristics. Coincidence factor, contribution factor loss factor. Relationship between the load factor and loss factor. Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics.

UNIT-II
OBJECTIVE
This unit deals with distribution feeders, its design considerations and types of feeders.

SYLLABUS
DISTRIBUTION FEEDERS: Design considerations of distribution feeders: Radial and loop types of primary feeders, voltage levels, feeder loading; basic design practice of the secondary distribution system.

UNIT-III
OBJECTIVE
This unit gives an idea regarding the sub-stations their location and ratings.

SYLLABUS
SUBSTATIONS: Location of Substations: Rating of distribution substation, service area within primary feeders. Benefits derived through optimal location of substations.

UNIT-IV
OBJECTIVE
This unit gives an idea regarding the power system analysis and a few derivations for calculation of power losses and voltage drop in lines.

SYLLABUS
SYSTEM ANALYSIS: Voltage drop and power-loss calculations: Derivation for voltage drop and power loss in lines, manual methods of solution for radial networks, three phase balanced primary lines.

UNIT-V
OBJECTIVE
This unit presents a good idea on the protection of the distribution system and its components.

SYLLABUS
PROTECTION: Objectives of distribution system protection, types of common faults and procedure for fault calculations. Protective Devices: Principle of operation of Fuses, Circuit Reclosures, line sectionalizes, and circuit breakers

UNIT-VI
OBJECTIVE
This unit gives us the coordination procedures for different types of protective devices.

SYLLABUS
COORDINATION: Coordination of Protective Devices: General coordination procedure.

UNIT-VII
OBJECTIVE
It deals with compensation for power factor improvement by using different types of capacitors.

SYLLABUS
COMPENSATION FOR POWER FACTOR IMPROVEMENT: Capacitive compensation for powerfactor control. Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched), Power factor correction, capacitor allocation. Economic justification. Procedure to determine the best capacitor location.

UNIT-VIII
OBJECTIVE
This unit deals with the voltage control and the effect of the compensating components on the voltage control.

SYLLABUS
VOLTAGE CONTROL: Voltage Control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation.

7.6.4.2 GATE SYLLABUS

UNIT-I
General concepts, co-incidence factor, contribution factor, loss factor, relationship between load factor and loss factor.

UNIT-II
Not applicable.

UNIT-III
Not applicable.

UNIT-IV
System analysis, voltage drop and power loss calculations.

UNIT-V
Protection, objectives of distribution system protection, types of common faults and procedure for fault calculations, protective devices, principle of operation of circuit breakers.

UNIT-VI
Not applicable.

UNIT-VII
Compensation for power factor improvement, capacitive compensation for power factor control, economic operation.

UNIT-VIII
Voltage control, equipment for voltage control.

7.6.4.3 IES SYLLABUS

UNIT-I
General concepts, co-incidence factor, contribution factor, loss factor, relationship between load factor and loss factor.

UNIT-II
Not applicable.

UNIT-III
Not applicable.

UNIT-IV
System analysis, voltage drop and power loss calculations.

UNIT-V
Protection, objectives of distribution system protection, types of common faults and procedure for fault calculations, protective devices, principle of operation of circuit breakers.

UNIT-VI
Not applicable.

UNIT-VII
Compensation for power factor improvement, capacitive compensation for power factor control, economic operation.

UNIT-VIII
Voltage control, equipment for voltage control.

7.6.5 SUGGESTED BOOKS

TEXT BOOKS

T1 Electric Power Distribution System Engineering, Turan Gonen, CRC press, Taylor & Fracis Group, 2nd edition.

REFERENCE BOOKS

R1 Electric Power Distribution, A.S. Pabla, Tata Mc Graw-hill Publishing Company, 4th edition, 1997.
R2 Electric Power Systems, CL Wadwa, New Age Publishing House.
R3 Power System Dynamics: Stability and Control, K.R. Padiyar, Interline publishing Pvt. Ltd.
R4 Generation, Transmission and Utilization of Electrical Energy, B.N. Singh
R5 An introduction to Electrical Distribution Systems, Dr. V. Kamaraju, Overseas Publishers.

7.6.6 WEBSITES

1. www.ieee.org
2. www.iitm.ac.in
3. www.iitd.ac.in
4. www.iitk.ac.in
5. www.iitb.ac.in
6. www.iitg.ernet.in
7. www.iisc.ernet.in
8. www.ieeecsss.org

7.3.7 EXPERTS' DETAILS

INTERNATIONAL

1. H. Song
ALSTOM,
ESCA, Bellevue,
WA 98004, USA
E-mail : haili.song@esca.com

2. C.C. Liu
Dept. of Electrical Engineering,
University of Washington,
Seattle, WA 98195, USA
E-mail: liu@eewashington.edu

NATIONAL

1. Dr. M. Vidyalingam
Professor,
Dept. of Electrical and Electronics,
SSN College of Engineering,
Old Mahabalipuram Road,
SSN Nagar, Tamil Nadu-603110,
India.
E-mail: info@ssnce.ac.in

2. Prof. S.V. Kulakarni
Dept. of Electrical Engineering,
Indian Institute of Technology, Bombay
Powai, Mumbai-400076, India.
E-mail : svk@ee.iitb.ac.in

2. Prof. Mangal Vadekar
Dept. of Electrical Engineering,
VJTI, University of Mumbai,
Mumbai.
www.vjti.ac.in

REGIONAL

1. Prof. M. Vijaya Kumar
Professor & Head
Dept. of Electrical Engineering.
JNTU College of Engineering,
Anantapur, Andhra Pradesh.
E-mail: mvk_2004@rediffmail.com

2. Prof. Tulsi Ramdas
   Professor,
   Dept. of Electrical Engg,
   JNTU College of Engineering,
   Kukatpally, Hyderabad.

3. Prof. B.V. Sankar Ram,
   Dept. of Electrical Engineering
   Dept. of Electrical Engg,
   JNTU College of Engineering,
   Kukatpally, Hyderabad.
   www.jntu.ac.in

7.6.8 JOURNALS

1. IEEE Transactions on Power Systems
2. IEEE Transactions on Power Appartus and Systems
3. IEEE Proceedings on Generation, Transmission and Distribution
4. IEI Electrical Engineering
5. Electrical Power and Energy Systems
6. Electrical India
7. Electrical Engineering Updates

7.6.9 FINDINGS AND DEVELOPMENTS

1. A novel hybrid network architecture to increase DG insertion in electrical distribution systems, Marie-Cecile Alvarez-Herault, Student Member, IEEE, Damien Picault, Raphael Caire, Member, IEEE, Bertrand Raison, Member, IEEE, Nouredine HadjSaid, Senior Member, IEEE, and Wojciech Bienia, IEEE Trans. on Power Systems, Vol. 26, No. 2, May 2011.

2. Cause-effect modeling and spatial-temporal simulation of power distribution fault events, Yixin Cai, Student Member, IEEE, and Mo-Yuen Chow, Fellow, IEEE, IEEE Trans. on Power Systems, Vol. 26, No. 2, May 2011.

3. Enhanced utilization of voltage control resources with distributed generation, Andrew Keane, Member, IEEE, Luis (Nando) F. Ochoa, Member, IEEE, Eknath Vittal, Student Member, IEEE, Chris J. Dent, Member, IEEE, and Gareth P. Harrison, Member, IEEE, IEEE Trans. on Power Systems, Vol. 26, No. 1, Feb. 2011.

4. Optimal contract pricing of distributed generation in distribution networks, Jesus Maria Lopez-Lezama, Student Member, IEEE, Antonio Padilha-Feltrin, Senior Member, IEEE, Javier Contreras, Senior Member, IEEE, and Jose Ignacio Munoz, IEEE Trans. on Power Systems, Vol. 26, No. 1, Feb. 2011.

5. Statistical representation of distribution system loads using gaussian mixture model, Ravindra Singh, Student Member, IEEE, Bikash C. Pal, Senior Member, IEEE, and Rabih A. Jabr, Member, IEEE, IEEE Trans. on Power Systems, Vol. 25, No. 1, Feb. 2010.

6. Optimal renewable resources mix for distribution system energy loss minimization, Y.M. Atwa, Student Member, IEEE, E.F. El-Saadany, Senior Member, IEEE, M.M.A. Salama, Fellow, IEEE, and R. Seethapathy, Member, IEEE, IEEE Trans. on Power Systems, Vol. 25, No. 1, Feb. 2010.

7. Short-term load forecasting: Similar day-based wavelet neural networks, Ying Chen, Peter B. Luh, Fellow, IEEE, Che Guan, Yige Zhao, Laurent D. Michel, Matthew A. Coolbeth, Peter B. Friedland, and Stephen J. Rourke, Senior Member, IEEE, IEEE Trans. on Power Systems, Vol. 25, No. 1, Feb. 2010.

8. Unsymmetrical short-circuit fault analysis for weakly meshed distribution systems, Jen-Hao Teng, Member, IEEE, IEEE Trans. on Power Systems, Vol. 25, No. 1, Feb. 2010.

7.6.10 i. SESSION PLAN

Sl. No.	Topics in JNTU Syllabus	Modules and Sub modules	Lecture No.	Suggested Books	
			UNIT-I		
1	Introduction to distribution systems	Introduction to the subject	L1	T1-Ch1, R1-Ch1 R1-Ch6	
2	Load modeling and characteristics	Definition of different types of loads and their characteristics	L2	T1-Ch2, R1-Ch2	IES, GATE
3	Definition of general concepts	Co-incidence factor, contribution factor, load factor, loss factor and others definitions, numericals	L3	T1-Ch2, R1-Ch2 R1-Ch7	IES, GATE
4	Relationship between load and loss factors	Demand curves, load duration curves their characteristics, numericals	L4 L5	T1-Ch2, R1-Ch2	
5	Classification of loads and their characteristics	Load growth, forecasting and diversified demands	L6	T1-Ch1, Ch2 R1-Ch2	
6	Regression analysis	Analysis of certain forecasting methods	L7 L8	T1-Ch2, R1-Ch2	
			UNIT-II		
7	Introduction of distribution feeder, design considerations	Introduction to primary and secondary distribution	L9	T1-Ch5	
8	Radial and loop types of primary feeders	Factors effecting selection, feeder arrangement Numericals	L10 L11 L12	T1-Ch5, R1-Ch5	
9	Voltage levels, feeder loading	Feeder loading and voltage drop considerations with different loadings Numericals	L13 L14 L15	T1-Ch5, R1-Ch5	

10	Basic design practice of the secondary distribution system	Introduction to secondary distribution systems, voltage levels, design considerations, numericals	L16 L17	T1-Ch6	
			UNIT-III		
11	Substations, location, ratings	Introduction to substations, types, components, equipment, layout, location and size	L18 L19	T1-Ch4, R1-Ch12	
12	Service area with in primary feeders	General case: Substation service area with N primary feeders-derivation Numericals	L20 L21	T1-Ch4	
13	Benefits from optimal location of substations	Location of substation illustrating typical bus schemes	L22 L23	T1-Ch4	
		UNIT-IV			
14	System analysis	Voltage drop and power loss calculations	L24	T1-Ch7	
15	Derivation for voltage drop and power loss in lines	Derivation, voltage drop computation based on load density, underground cable distribution, economic analysis of equipment losses Numericals	L25 L26	T1-Ch7, R5-Ch6	
16	Manual methods of solution for radial networks	Radial network with uniformly and non- uniformly distributed load Numericals	L27 L28 L29	T1-Ch5, R5-Ch6	
17	Three phase balanced primary lines	Introduction, voltage drop and power loss calculation due to load current	L30 L31	T1-Ch7	
			UNIT-V		
18	Objectives of distribution system protection	Introduction basic definitions and requirements	L32 L33	T1-Ch10,R1-Ch15	
19	Types of common fault and procedure for fault calculations	Introduction types of faults-LG, LL, LLG, 3-phase faults, Fault analysis for distribution system, fault current calculation	L34 L35 L36	T1-Ch10	GATE, IES
20	Protective devices	Fuses, circuit breakers, automatic line sectionalizers	L37	T1-Ch10	GATE, IES

21	Principle of operation of fuses, circuit breakers, circuit reclosures, line sectionalizers	Over current protection fuses, types, ratings Numericals	L38 L39 L40	T1-Ch10,R1-Ch15	
UNIT-VI					
22	Coordination of protective devices	Fuse-fuse, fuse-circuit breakers, fuse-reclosure, reclosure- circuit breakers, reclosure-substation transformer high side fuse coordination	L41 L42	T1-Ch10,R1-Ch15	
23	General coordination procedure	General procedure of coordination for protective devices	L43	T1-Ch10	
UNIT-VII					
24	Capacitive compensation for power factor improvement	Introduction to power factor analysis	L44	T1-Ch8	GATE, IES
25	Types of power capacitors, effect of shunt capacitors on power factor correction	Fixed and switched application of series capacitors to voltage regulators	L45 L46 L47	T1-Ch8, R1-Ch13	GATE, IES
26	Capacitor allocation economic justification	Procedure to determine best capacitor location, benefits with capacitor installation	L48 L49	T1-Ch8, R1-Ch13	GATE, IES
UNIT-VIII					
27	Voltage control Equipment for voltage control	Introduction, basic definitions, quality of service and voltage standards	L50 L51	T1-Ch9, R5-Ch11	GATE, IES
28	Effect of series capacitors	Voltage improvement using capacitor banks Numericals	L52 L53 L54	T1-Ch9, R5-Ch11	GATE, IES
29	Effect of AVB/ AVR	Voltage control by feeder voltage regulators, transformers tap changing, voltage boosters	L55 L56	T1-Ch9, R5-Ch11	GATE, IES
30	Line drop compensation	Voltage control by using line drop compensation	L57	T1-Ch9, R5-Ch11	

ii. TUTORIAL PLAN

Sl. No.	Topics Scheduled	Salient topics to be discussed
1	Definition of general concepts & characteristics of different loads	Numerical problems on load characteristics & forecasting
2	Distribution feeder design considerations, feeder loading	Numerical problems on feeder loading and voltage drop considerations with difference loadings
3	Classification of distribution systems	Numerical problems on primary and secondary distribution network
4	Derivation for voltage drop and power loss calculations	Problems to determine voltage drop and power loss
5	Radial networks	Numerical problems on radial network with uniformly and non-uniformly distributes load
6	Different types of faults & fault analysis for distribution systems	Numerical problems on faults
7	Importance of power factor improvement and different compensation techniques for power factor improvement	Numerical problems on power factor correction
8	Reactive power compensation and application of capacitors	Power factor analysis, mathematical calculations using capacitors
9	Need of voltage control	Numerical problems based on voltage improvement using capacitor banks
10	Principle of operation of fuses and circuit breakers	Numerical problems
11	Various methods of load forecasting	Regression analysis and other such methods
12	Substation service area with N-primary feeders derivation	Numerical problems
13	Reactive power compensation and application of capacitors	Power factor analysis mathematical calculating using capacitors
14	General coordination between different types of protective equipment	Procedure for coordination between different types of protective devices.

7.6.11 STUDENT SEMINAR TOPICS

1. Load forecasting using hybrid model, M. Hanmandlu and b.K. Chauhan, IEEE Trans. on Power Systems, Feb 2011, Vol. 26, No. 1.
2. Dynamic analysis of a grid-connected marine-current power generation system connected to a distribution system, L. Wang and J.H. Liu, IEEE Trans. on Power Systems, Nov. 2010, Vol. 25, No. 4.
3. Using integrated model assess the efficiency of electric distribution companies, Mohsen simals, Student Member, IEEE, IEEE Trans. on Power Systems, Nov. 2010, Vol. 25, No. 4.
4. Cordination of inverter owned DG-capacity growth in distribution systems, S. Wong, K. Bhattacharya, and J.D. Fuller, IEEE Trans. on Power Systems, Aug. 2010, Vol. 25, No. 3.
5. Load calibration and model validation methodologies for power distribution systems, Y. Liang, K.S. Tam, and R. Broadwater, IEEE Trans. on Power Systems, Aug. 2010, Vol. 25, No. 3.
6. Application of grey correlation analysis in evolutionary programming for distribution system feeder reconfiguration, M.S. Tsai and F-Y. Hsu, IEEE Trans. on Power Systems, May. 2010, Vol. 25, No. 2.

7.6.12 QUESTION BANK

UNIT-I

1. i) Give the classification of loads and draw their characteristics
   ii) Obtain the relationship between the load factor and loss factor **(May 13)**

2. i) List out and explain the various control functions in distribution automation.

   ii) Write in detail about commercial and agricultural loads and their respective characteristics.

   (Dec 12 (R07))

3. i. Derive relationship between load factor and loss factor.
   ii. What are the different types of loads? Discuss their characteristics. **(Dec 12)**

4. Why loads are classified in distribution systems and how they are classified? Also explain their different characteristics. **(Dec 11)**

5. i. The total annual copper loss of the feeder is 20000kWh and load factor is 0.32. Then find average power loss of the feeder.
   ii. Show that load factor = loss factor = t/T for zero off - peak load. **(Dec 11)**

6. i. Assume that a load of 100kW is connected at the riverside substation. The 15min. weekly maximum demand is given as 75kW, and the weekly energy consumption is 4200kWh. Assuming a week is 7 days, fine the demand factor and the 15min. weekly load factor of the substation.
   ii. Classify different types of distribution loads and specify their voltage levels. **(Dec 11)**

7. i. A small city experiences an annual peak load of 3500kW. The total annual energy supplied to the primary feeder circuits is $10x10^6$ kWh. The peak demand occurs in July/August and is due to air conditioning load:
   a. Find the annual average power demand
   b. Find the annual load factor
   c. Find the annual loss factor.
   ii. Explain the characteristics of commercial and agricultural loads. **(Dec 11)**

8. i. For what contribution factor, the coincident factor is equal to contribution factor. Also define contribution and coincident factor
   ii. The annual peak load of substation is 3500kW. The annual energy supplied to the primary feeder circuit is 20 x 106 kWh. Find:

a. The annual average power demand
b. The annual load factor. **(May 11)**

9. i. Give the classification of loads and draw their characteristics.
   ii. A load of 100 kW is connected at the riverside substation. The 15 min. weekly maximum demand is given by 75 kW and the weekly energy consumption is 4200kWh. Find the demand factor, the 15 min. weekly load factor of the substation and its associate loss factor. **(May 11, Nov 10)**

10. Discuss the following factors of the distribution system:
   i. Demand factor
   ii. Plant factor
   iii. Load factor
   iv. Diversity factor
   v. Contribution factor
   vi. Coincident factor
   vii. Loss factor. **(May 11)**

11. i. A 50MW hydro generator delivers 320 million kWh during the year. Calculate the plant load factor.
   ii. Explain the load characteristics of distribution system. **(Nov 10)**

12. Discuss different types of loads present in distribution system and explain their characteristics. **(Nov 10)**

13. i. What is meant by load modeling and give their characteristics?
   ii. Define the following:
   a. Coincidence factor
   b. Load factor
   c. Loss factor
   d. Contribution factor. **(Nov 09, 08, May 09)**

14. Explain about load modelling and characteristics of different types load models. **(Nov 09)**

15. Explain the characteristics of residential, industrial and commercial loads. **(Nov 09)**

16. i. Explain load modeling and their characteristics.
   ii. The annual peak load of a substation is 5000KW and the total annual energy supplied to the feeder is 15×10^5 KWh. The peak demand occurs is demand due to A-C load then find
   a. Annual average power demand
   b. Annual load factor
   c. Annual loss factor using approximate formula. **(Nov 09)**

17. i. Obtain the relationship between loss factor and load factor. **(Nov 09)**
   ii. What is a distribution system? What are the different types of load that are connected to this system?
   iii. What is the significance of diversify factor and demand factor with respect to distribution system?

18. Why loads are classified in distribution systems and how they are classified? Also explain their different characteristics. **(May 09, Nov 08)**

19. Draw a block diagram in flow chart form for a typical distribution system planning process and explain the techniques for distribution planning. **(May 09, Nov 08, 07, 04, Feb 08, 07)**

20. i. Explain how the load growth in a distribution system can be obtained.
   ii. A distribution substation experiences an annual peak load of 3,500 kW. The total annual energy supplied to the primary feeder circuits is 10^7 kWh. Find
   a. the annual average power
   b. the annual load factor **(May 09, 05, Nov, Feb 07, 06, 05, 04)**

21. Explain the different control functions used for distribution automation. **(May 09, Nov 04)**

22. Write in detail about commercial and agricultural loads and their respective characteristics. **(May 09)**

23. The annual peak load input to a primary feeder is 2000 Kw. A computer program which calculates voltage drops and copper looses shows that the total copper loss at the time of peak load is ΣI^2R= 100 Kw. The total annual energy supplied to the sending end of feeder is 5.61×10^6 Kwh, Then
    i. Determine the annual loss factor
    ii. Calculate the total annual copper loss energy and its value at $ 0.03/Kwh. **(May 09)**

24. i. Define coincidence factor and contribution factor.
    ii. Obtain the relation between the load factor and loss factor. **(Nov 08)**

25. i. Prove that approximate formula for loss factor(FLS) = $0.3F_{LD} + 0.7F^2_{LD}$, where F_{LD} = load factor.
    ii. The annual average load is 1241 kW and monthly peak load is 3600kW. Find the load factor and loss factor by using approximate formula. **(Nov 08)**

26. i. Discuss the effect of load factor and diversity factor on the cost of generation in a power system.
    ii. Assume that the annual peak-load input to a primary feeder is 2000 kW. The total copper loss at the time of peak-load is 100 kW. The total annual energy supplied to the sending end of the feeder is 5.61×10^6 kWH. Determine
    a. the annual loss factor
    b. the total annual copper loss energy and its value at Rs.1.5 per kWh. **(Nov 08, 07, 05 Feb 07)**

27. Discuss the objectives of distribution system planning. **(Nov, Feb 08, 07, 05)**

28. i. Explain briefly the classification of Loads.
    ii. A power supply is having the following loads.

    If the overall system diversity factor is 1.35, determine
    i. maximum demand
    ii. connected load of each type **(Nov 08, 05, Feb 07)**

29. i. Derive the relationship between the load and loss factors.
    ii. The input to a sub transmission system is 87.6×10^6 kWh annually. On the peak-load day of the year, the peak is 25, 000kW and the energy input that day is 3×10^5 kWh. Find the load factors for the year and for the peak-load day. **(Nov 08, 06)**

30. i. What is meant by the term load? How loads can be classified?
    ii. Define: Demand, load duration curve and Annual load duration curve.
    ii. Explain how maximum demand and average demand can be obtained from daily demand variation curve. **(Nov 08, 07, 06)**

31. Examine the present trend for the future distribution system planning. **(Feb 08, 07, Nov 07, 06, 05)**

32. i. Explain the following terms
    a. maximum demand
    b. coincident demand and
    c. non - coincident demand
    ii. Explain following factors
    a. Contribution factor
    b. load diversity
    c. loss factor **(Feb 08, 07, Nov 06)**

33. i. Explain the characteristics of different types of Load models.
    ii. Assume that the annual peak load of a primary feeder is 2,000 kW, at which the power is 80kW per three phase. Assuming an annual loss factor of 0.15, determine
    a. the average annual power loss
    b. the total annual energy loss due to the copper losses of the feeder. **(Feb 08, Nov 05)**

34. Explain: Load factor and diversity factor. **(Feb 08)**

35. Explain the various factors affecting the distribution system planning. **(Feb 07, Nov 06, 05, May 05)**

36. i. What is the need for mathematical models to represent the system? Name the different operations research techniques used by planners, for planning a distribution system.
    ii. Discuss about the three factors which affect the distribution system planning in the near future. **(Nov 06, 04)**

37. i. What informations can be obtained from the load duration curve?
    ii. Explain the following factors:
    a. Demand factors b. Connected load c. Utilization factor d. Plant factor. **(Nov 04)**

38. Draw the schematic view of a distribution system planning, and explain the role of computer in distribution system planning. **(Nov 04)**

39. i. Explain how a load duration curve is plotted. What is its age?
    ii. A distribution substation supplies the following loads: 15,000 kW, 8,500 kW, 6,000 kW and 450 kW. The station has a maximum demand of 22,000 kW. The annual load factor of the station is 48%.
    Calculate
    a. the energy supplied annually b. the diversity factor and c. the demand factor **(Nov, May 04)**

40. i. Write the importance of electrical distribution systems and their applications?
    ii. What are the different types of supply systems that are adopted for transmission of electrical power.

UNIT-II

1. i) Assume that feeder has a length of 2 miles and that the new feeder uniform loading has increased to 3 times the old feeder loading. Determine the new maximum length of the feeder with the same percent voltage drop if the new feeder voltage level is increased to 34.5kV from the previous voltage level of 12.47kV.

   ii) Explain basic design practice of secondary distribution system and also discuss about secondary banking. **(May 13)**

2. i) Compare the various switching schemes by clearly mentioning the advantage and the disadvantages of earthing.

   ii) Explain the rectangular type development and radial-type development in case of feeders**.(Dec12 (R07))**

3. i. Explain the basic design practice of secondary distribution systems.
   ii. A 300m distributor fed from both ends F_1 and F_2 is loaded uniformly at the rate of 2A/m run. The resistance of loop is 0.2 λ/km. Find the minimum voltage and the point where μ occurs, if the feeding F_1 and F_2 are maintained at 225V and 220V respectively. Also find the currents supplied from the feeding points F_1 and F_2. **(Dec 12)**

4. i. Distinguish between a feeder, distributor and service mains in a secondary distribution scheme.
   ii. Show that with an increase in working voltage to 'n times, the cross section of a feeder and a distributor would be reduced to 1/n and $1/n^2$ of their respective values. **(Dec 11)**

5. i. Explain the basic design practice of secondary distribution system.
   ii. Mention different standard voltage levels of secondary distribution system.
   iii. Find the new load and area that can be served with the same percent voltage drop if the new feeder voltage level is increased to twice the previous voltage level of the feeder. **(Dec 11)**

6. Give comparison between four and six feeder patterns. **(Dec 11)**

7. i. Draw and explain secondary network supplied by three primary feeders.
   ii. Discuss how number of feeders are decided by given primary feeder loading. **(Dec 11)**

8. i. Assume that the service area pf a given feeder is increasing as a result of new residential developments. Determine the new load and area that can be served with the same percent voltage drop if the new feeder voltage level is increased to 34.5 kV from the previous voltage level of 12.47kV.
   ii. Discuss in detail the factors which influence the selection of primary feeder rating. **(May 11, Nov 08)**

9. i. Draw and explain one line diagram of typical primary distribution feeder.
   ii. Draw and explain one line diagram of secondary network of the distribution feeder. **(May 11, Nov 08)**

10. Give the various loading and voltage level factors that influence the design and operation of primary feeders. **(May 11, 05, Nov, Feb 08, 07, 06, 05)**

11. i. Classify different types of primary feeders and give their merits and demerits.
    ii. Explain basic design practice of secondary distribution system and also discuss about secondary banking. **(Nov 10)**

12. Assume that a star connected three phase load is made up of three impedances of 506 250 ohms each and that the load is supplied by a three phase four wire primary express feeder. The balanced line to neutral voltages at the receiving end are $v_{an} = 7630 \angle 0^0$V, $v_{bn} = 7630 \angle 240^0$V, $v_{cn} = 7630 \angle 120^0$V. Determine the following:
    i. The phase currents in each line
    ii. The line to line phasor voltages
    iii. The total active and reactive power supplied to the load. **(Nov 10)**

13. What is meant by primary feeder loading? Give some of the factors which will affect the design loading of a feeder. **(Nov 10)**

14. i. Classify the types of primary feeders and give the applications of each type primary feeder.
    ii. Draw and explain one line diagram of secondary distribution system and explain the parts of it. **(Nov 10)**

15. Explain single line diagram of a simple radial secondary distribution and explain design practice of this system. **(Nov 09)**

16. i. Explain various factors that influences the number of conductors and size of conductor of primary feeder.
    ii. Distinguish between a feeder, distributor and service mains in a secondary distribution system. **(Nov 09)**

17. i. Explain the basic design consideration of primary feeders.
    ii. State the different voltage levels of secondary distribution system. **(Nov 09)**

18 Explain the different types of distribution feeders. Also, state the advantages and disadvantages of different feeders. **(Nov 09)**

19. Draw the one line diagram of radial type primary feeder and mention the factors that influences the selection of primary feeder. **(May 09, Nov 08, 07, 05, 04)**

20. What are the various factors that influence the voltage levels in the design and operation of the distribution system? **(May 09, Nov, Feb 08, 07, 06)**

21. Explain with neat sketches radial type and loop type sub transmission systems. **(May 09)**

22. i. Define the terms: (a) feeder and (b) Distributor.
    ii. State the differences between primary and secondary distribution lines as regards to voltage used, load carried, number of conductors and size of insulators. **(May 09)**

23. How do you optimally locate the substations and explain the benefits derived from optimal location. **(May 09)**

24. i. Explain radial type primary feeder with neat diagram.
    ii. Assume that feeder has a length of 2 miles and that the new feeder uniform loading has increased to 3 times the old feeder loading. Determine the new maximum length of the feeder with the same percent voltage drop if the new feeder voltage level is increased to 34.5kV from the previous voltage level of 12.47kV. **(Nov 08)**

25. i. What is meant by express feeder and give its importance in operation of radial type primary feeder?
    ii. Explain different connection diagrams of radial primary feeder. **(Nov 08)**

26. What are the various factors that are to be considered in selecting a primary feeder rating? Describe the arrangement with suitable diagram. **(Nov 08, 06, 05, Feb 07)**

27. A 3 phase radial express feeder has a line to line voltage of 22.0 kv at the receiving end, a total impedance of 5.25 + j10.95ohm/phase, and a load of 5 MW with a lagging power factor of 0.90. Determine the following:
    a. The line to neutral and line to line voltages at the sending end.
    b. The load angle. **(Nov, Feb 08, 07, 06)**

28. At the end of a power distribution system, a certain feeder supplies three distribution transformer, each one supplying a group of customers whose connected loads are as under.

    If the diversity factor among the transformer is 1.3, find the maximum load on the feeder. **(Feb 08, Nov 06)**

29. i. Compare the Radial and Loop type primary feeders.
    ii. What are the various factors that influence the primary feeder loading. **(Feb 08, Nov 04)**

30. Explain various types of radial primary feeders with diagrams. **(Feb 08, Nov 05, 04)**

31. i. How do you apply the concept of ABCD constants to radial feeders.
    ii. Derive an equation for receiving end voltage. **(Nov, Feb 07)**

32. Derive the equations for voltage drop and power loss in a radial feeder with uniformly distributed load. **(Nov 07, 05, 04)**

33. What is the distribution system how is it sub divided to cater the needs of the customers.

34. Consider the radial feeder in which the load is connected at the receiving and the feeder impedance is 0.1 + j0.1 p.u. the sending end voltage is 1.0 p.u. The real power load and p.f. at receiving end or 1.0 p.u. and 0.8 lagging respectively. Determine receiving and voltage, load angle and fine the corresponding values of the receiving end and sending end currents.

35. i. Write short note on voltage level.
    ii. Explain the secondary distribution system.

36. i. What are the various design considerations of secondary distribution system.
    ii. What is the importance of percentage voltage drop in feeder lines. What are the various factors that effect percentage voltage drop.

37. A 230V 1-phase feeder has resistance and reactance per km as 1.5+j0.6 ohm. What is the load it can supply with %VD = 5.0 when
    i. Load is uniformly distributed
    ii. Located at the feeder end
    iii. Uniformly decreasing load
    Take feeder length = 1.5 km.

38. An industrial area near a city was found to have a load density of 0.5 MVA / km^2 the total area was to be located between a rectangular strip of 8 km x 4 km. Determine suitable no. of 33/11 kV substations their capacity and feeder length. The loads are to be served by 11kV feeders.

39. A 3-phase 11kV line uses 7/3.15 mm A.C. conductor the conductor spacing is horizontal with 1.1 meter spacing. The loading is uniformly distributed with 800kVA. Find the maximum length to which feeder can be used if %VD is to be lessthan 6%.

40. What are the differences between and secondary distribution systems.

41. A service area is 10 km x 8 km and has a load density of 300kVA/km^2 comprising of domestic commercial and industrial loads. Design suitable distribution system given:
    i. The supply can be tapped from an existing 33kV lines
    ii. The standard system voltages are 33kV, 11kV and 6.6 kV.
    iii. Not morethan two 33kV substations are premisable.

42. What is the total annual cost (TAC) in distribution system. How does it help in effective design of distribution system.

43. How are the sub distribution network and LT distribution networks formed. Illustrate with suitable examples.

UNIT-III

1. i) How do you analyze a substation service area with `n' primary feeders.

   ii) Discuss the benefits, which are derived through optimal location of substations **(May 13)**

2. i. What are the factors considered when selecting a location for a substation?
   ii. Explain the procedure for optimal location of substation. **(Dec 12)**

3. i. Calculate the % voltage drop in the main if load 500kVA is uniformly distributed along the feeder main, is shown in figure Consider k = 0.01%VD/(kVA.mi).

   ii. Explain the rules to be considered to locate the substation.
   iii. Define `k' constant and give its importance. **(Dec 11)**

4. i. A 3 -ϕ, 4.16kV wye grounded feeder main has 4 copper conductors with an equivalent spacing of 1.0 m between phase conductors and a lagging load power factor of 0.9. Determine the `k' constant of the main feeder. Let r = 1.503Ω/m and x=0.7456 Ω/m. Also calculate the percent voltage drop in the main if a lumped sum load of 500 kVA with a lagging p.f. of 0.9 is connected at the end of 1m long feeder main.
   ii. List out the benefits obtained from optimal location of substations. **(Dec, May 11, Nov 10)**

5. i. Draw the primary network which is supplied by number of substations.
   ii. Define secondary banking and explain different connections of secondary banking.

6. Obtain the percentage voltage drop of substation service area served with `n' primary feeders and each feeder serves an area of triangular shape. **(Dec 11, Nov 09)**

7. Compare the four and six feeder patterns of substation service area if they are voltage drop limited. **(May 11)**

8. i. Explain the procedure to fix the rating of a substation.
   ii. Calculate the percent voltage drop in the main of given 3 - phase feeder of 4.16 kV having r = 1/3 ohms/mi, x = 0.8 ohms/mi and 560 kVA load is uniformly distributed along the feeder main of length 1 mile. Assume p.f. = 0.92. **(May 11)**

9. i. Calculate the % voltage drop in the main if load 500kVA is uniformly distributed along the feeder main, is shown in figure Consider k = 0.01%VD/(kVA.mi).

ii. Explain the rules to be considered to locate the substation.
iii. Define `k' constant and give its importance. **(May 11)**

10. Derive the equation for `k' constant in voltage drop calculations of substation supplied with `n' primary feeders. **(Nov 10)**

11. Derive the total area served by four feeders is 0.667 times the total area served by six feeders if they are thermally loaded. **(Nov 10)**

12. Compare the four and six feeder patterns of substation service area if they are thermally loaded. **(Nov 10)**

13. i. Explain the various factors to be considered to decide the ideal location of substation.
ii. Explain how to decide the rating of a distribution substation. **(Nov 09, 08)**

14. i. What are the various factors that are to be considered in selecting substation location.
ii. Compare the four and six feeders patterns. **(Nov 09, 08, 05, Feb 07)**

15. State the benefits obtained through optimal location of substation. **(Nov 09)**

16. i. Explain the methodology to fix the rating of a distribution substation?
ii. Explain various factors to be considered in loading a substation? **(Nov 09)**

17. Give the classification of different types of substations. State the advantages and disadvantages of each substation. **(Nov 09)**

18. i. With neat sketches explain the various types of sub transmission systems.
ii. How the rating of distribution substation can be calculated. Explain taking a general case with ‘n’ no. of feeders. **(May 09)**

19. Explain the Rectangular-Type Development and Radial- Type Development in case of feeders. **(May 09)**

20. Discuss the benefits, which are derived through optimal location of substations. **(May 09, Nov 08)**

12. Compute percent voltage drop of substation service area supplied with ‘n’ primary feeders. Assume load is uniformly distributed. **(Nov 08)**

22. Calculate % voltage drop of hexagonally shaped area of distribution substation. **(Nov 08)**

23. How do you analyse a substation service area with ‘n’ primary feeders. **(Nov, Feb 08, 07, 05, 04 May 05)**

24. Give a detailed analysis of square shaped and hexagonal shaped distribution sub-station areas. **(Nov 08, 06, 04, Feb 07)**

25. What are the various factors that influence the voltage levels in the design and operation of the distribution system? **(Feb 08)**

26. Compare the four and six feeders patterns. **(Feb 08)**

27. Explain the procedure for the location of a substation. Enumerate the various factors affecting the selection of site for a substation. **(Nov, May 04)**

28. Explain rating of the distribution system.

29. Explain the optimal location of substations.

30. List the equipment that a distribution substation compresses with a line diagram.

30. Explain distribution substation location and planning.

32. Give the arrangement of a single transformer 11000/415 Volts substation and described its layout.

33. i. What are the features of large size substation?
ii. Briefly mention the equipment and the layout?

UNIT-IV

1. A 1-phase feeder circuit has total impedance (1+j3) ohms, receiving end voltage is 11kV and current is 50∟-30^0 A. Determine:
a) Power factor of load
b) load p.f. for which the drop is maximum
c) load p.f. for which impedance angle is maximum and derive the formula used. **(May 13)**

2. i) Explain single phase two wire uni grounded levels to calculate voltage drop and power loss.

ii) Consider three phase two wire 240V secondary system with balanced loads at A,B and C .Determine the following

a) Calculate total voltage drop

b) Calculate real power per phase for each load.

c) Reactive power per phase

d) KVA O/P and load power factor of distribution transformer. **(Dec 12 (R07))**

3. i) What are the disadvantages of constant voltage transmission?
ii. Derive an expression for the power loss in a uniformly - loaded distributor fed at one end. **(Dec 12)**

4. i. In terms of line parameters, derive the equation for load p.f. for which voltage drop is minimum.
ii. An unbalanced 3 - phase delta connected load is connected to a balanced 3-phase, 3-wire source. The load impedances Z_A = 60/_30^{0}Ω/ph, Z_B = 80/_-45^{0}Ω/ph and Z_C = 50/_65^{0}Ω/ ph respectively. The line voltage of A phase is 12.6 kV. Use the A phase to phase voltage as reference and determine the line currents and total real and reactive powers. **(Dec 11)**

5. i. Derive the expression for voltage drop and power loss in 3-phase balanced system.
ii. An unbalanced 3-phase star connected load is connected and balanced 3-phase, 4- wire source, the load impedance Z_a, Z_b and A_c are given by 70/_30^0 Ω/phase, 85/_40^{0}Ω/phase, 50/_35^0 Ω/phase respectively. The phase `a' line voltage has an effective value of 13.8kV. Use the line to neutral voltage of phase `a' as the reference and determine the following:
a. Line to neutral currents
b. Total power delivered to the load. **(Dec 11)**

6. i. Consider a balanced three phase circuit shown in figure R + jX represent the total impedance of the line. The power factor of the load is cos θ = cos ($\theta_{V R} - \theta_r$). Find the load power factor for which the voltage drop is maximum?

ii. Prove the power loss due to load currents in the conductors of the 2 phase, 3-wire lateral with multi - grounded neutral is approximately 1.64 times larger than the one in the equivalent three phase lateral. Also show that $VD_{pu;2\Phi}$ = 2 x $V_{Dpu;3\Phi}$ **(Dec 11)**

7. Illustrate the computation of the voltage drop of a balanced three phase feeder, supplied at one end in terms of the load and the line parameters. **(Dec 11)**

8. A single phase radial network is shown in fig. The resistance and reactance of each wire is 0.2 ohms and 0.3 ohms per meter respectively. The receiving end voltage is $220\angle 0^0$V. Then calculate:
   i. The voltage drop of each section of the line
   ii. Total voltage drop of the line
   iii. Total real power and real power and reactive power of the line. **(May 11)**

9. i. Derive the expressions for volt drop and power loss in lines.
   ii. Explain the manual method of solution for radial distribution systems. **(May 11)**

10. i. Give detailed analysis of three phase balanced primary lines
    ii. Consider a balanced 3 phase circuit having V_s and V_r are the sending and receiving end voltages respectively. R+jX is the total impedance of lines and I is the total current passing through the circuit. Find the load power factor for which the voltage drop is maximum? **(May 11)**

11. i. Derive the expression for voltage drop and power loss for non-three phase system.
    ii. Show that power loss due to load currents in the conductors of equivalent three phase lateral is approximately 1/1.64 times the two phase 3 wire lateral with multigrounded neutral. **(May 11)**

12. Draw and explain typical four - wire multi - grounded common neutral distribution system. **(Nov 10)**

13. Assume that a star connected three phase load is made up of three impedances of $50\angle 25^0$ ohms each and that the load is supplied by a three phase four wire primary express feeder. The balanced line to neutral voltages at the receiving end are $v_{an} = 7630\angle 0^0$V, $v_{bn} = 7630\angle 240^0$V, $v_{cn} = 7630\angle 120^0$ V. Determine the following:
    i. The phase currents in each line
    ii. The line to line phasor voltages
    iii. The total active and reactive power supplied to the load. **(Nov 10)**

14. Derive an approximate voltage drop & power loss equation of primary feeder and give the condition for load p.f. at which voltage drop is maximum. **(Nov 10, 09, 08, May 09)**

15. i. What are the di”erent types of manual methods used for the solution of radial networks and explain in detail.
    ii. Derive the equation for load p.f. for which the voltage drop is maximum. **(Nov 10, 09)**

16. i. In terms of line parameters, derive the equation for load p.f. for which voltage drop is minimum.
    ii. An unbalanced 3 - phase delta connected load is connected to a balanced 3-phase, 3-wire source. The load impedances ZA = $60\angle 30^0\Omega$/ph, ZB = $80\angle -45^0\Omega$/ph and ZC = $50\angle 35^0\Omega$/ ph respectively. The line voltage of A phase is 12.6 kV. Use the A phase to phase voltage as reference and determine the line currents and total real and reactive powers. **(Nov 10)**

17. i. Write about non - three phase primary lines.
    ii. Consider the 3 - phase, 3 wire 240 V secondary system with balanced loads at A, B and C as shown in figure. Determine the following:

    a. Calculate the total voltage drop
    b. Calculate the kVA output and load p.f. of the distribution transformer
    c. Calculate total power per phase for each load. **(Nov 09, 08)**

18. A single phase feeder circuit has total impedance (2+j6) ohms, receiving and voltage is 11KV and current is 40 $|\underline{-45^0}$ A. Determine
    i. P.f of load
    ii. Load p.f for which the drop is maximum
    iii. Load p.f for which impedance angle is maximum and also, derive the formula used. **(Nov 09)**

19. i. Obtain the expression for load power factor for which the voltage drop is minimum , in terms of resistance and reactance of the circuit..
    ii. Explain a four wire multi-grounded common neutral distribution system. **(Nov 09)**

20. i. Derive an expression for voltage drop in a three phase ac distributor.
    ii. Elctrical energy is supplied to a consumer from a substation at a distance of 250m.If the power required by the consumer is three phase 100KW at 415 v unity pf and resistance of single conductor of the connecting cable is 0.1/1000 ohms/m,calculate.
    a. the voltage at the bus bar of the substation
    b. the power loss in the cable. **(May 09)**

21. i. Derive an expression for voltage drop and power loss for uniformly radial type distribution load.
    ii. A 3 phase distribution line has resistance and reactance per phase of 15 ohm and 20 ohms respectively. If the sending end voltage is 33 Kv and regulation of the line is not to exceed 10 %. Find the maximum power in Kw which can be transmitted over the line. Find also the KVAR supplied by the line when delivering the maximum power. **(May 09)**

22. i. Explain single phase two wire unigrounded levels to calculate voltage drop and power loss.
    ii. Consider three phase three wire 240 V secondary system with balanced laods at A,B and C. Determine the following:
    a. Calculate the total voltage drop
    b. Calculate real power per phase for each load
    c. Reactive power per phase
    d. KVA o/p and load power factor of distribution transformer. **(May 09)**

23. i. Derive the voltage drop equation for anon uniform distributed laod.
    ii. A single phase feeder circuit has total impedance of (1+j3) Ω and V_R = 2400 $\angle 0^0$ 0 V and Ir = 50 $\angle -30^0$, respectively. Find
    a. Power factor of the load b. Load P.F. for which the drop is maximum. **(May 09)**

24. A 1-ϕ feeder circuit has total impedance (1+j3) Ω, receiving end voltage is 11kV and current is $50\angle - 30^0$ A. Determine:
    i. p.f. of load
    ii. load p.f. for which the drop is maximum
    iii. load p.f. for which impedance angle is maximum and derive the formula used. **(Nov 08)**

25. i. Prove the power loss due to load currents in the conductors of the 2-phase, 3 wire lateral with multi-grounded neutral is approximately 1.64 times larger than the one in the equivalent 3-phase lateral.
    ii. Consider the three phase, 3 wire 240V secondary system with balanced loads at A, B and C as shown in figure Determine: **(Nov 08)**

    a. The voltage drop in one phase of lateral
    b. The real power per phase for each load
    d. The reactive power per phase for each load.

26. i. In terms of resistance and reactance of the circuit, derive the equation for load power factor for which voltage drop is minimum.
    ii. An unbalanced 3-phase star connected load is connected to a balanced 3- phase, 4-wire source. The load impedances Z_R,Z_Y and Z_B are given as , 70/_30^0, 85/_- 40^0 and 500/_35^0 ohms per phase respectively and the phase 'R' line voltage has an effective value of 13.8 KV. Use the line to neutral voltage of phase 'R' as the reference and determine the line and neutral currents and total real and reactive powers.

(Nov 08, 07, 06 Feb 07)

27 i. Prove the power loss due to the load currents in the conductors of single-phase lateral ungrounded neutral case is 2 times large than one in the equivalent three phase lateral.
   ii. Prove the power loss due to load currents in the conductors of the single-phase two-wire ungrounded lateral with full capacity neutral is 6 times larger than the one in the equivalent three phase 4-wire lateral.

(Nov 08, 05, 04, Feb 07, May 04)

28. Consider the singe phase radial distributor shown in the following figure

the magnitude of load currents, p.fs and distances are indicated in the figure. The resistance and reactance of each wire are 0.1 ohm and 0.2ohms per km respectively. It is required to maintain voltage at point B as 230/_0^0Volts, find

i. voltage drop in the three sections
ii. total voltage drop in the feeder
iii. supply voltage, current and power factor
iv. KVA output of supply

The p.f. angles of individual loads are w.r.t. voltage at point B. **(Nov 08, 07, 05, May 05)**

29. i. Derive an approximate voltage-drop equation of primary feeder and give the condition for load power factor at which voltage drop is maximum.

ii. Consider a single-phase, 2-wire secondary distributor of length 'l' meters from the distribution transformer. At a length of 'l_1' meters from source, a load of 'I_1'amps with a p.f. of cos ϕ_1 (lag) is tapped. At a length of l_2 meters from first load, a second load of I_2 amps with a power factor cos ϕ_2 (lead) is taped. At a length of 'l_3' meters from second load, a third load of 'I_3'amps with a UPF is tapped. If resistance and reactance of each wire are r and x ohms/meter respectively, derive approximate voltage drop equation in the distributor.

(Feb 08, 07, Nov 07, 06, 04)

30. Consider the three phase, three wire 240V secondary system with balanced loads at A, B and C as shown in figure. Determine

i. the total voltage drop in one phase of lateral
ii. the real power per phase for each load
iii. the reactive power per phase for each load and
iv. the KVA output and load p.f. of the distribution transformer. **(Feb 08, Nov 05)**

31. i. A single phase a.c. distributor AB 300meters long is fed from end A and is loaded as under :

a. 100A at 0.707 p.f. (lag) 200m from point A
b. 200A at 0.8 p.f. (lag) 300m from point A

Total resistance and reactance of the distributor is 0.2ohms and 0.1ohms per km. Calculate the total voltage drop in the distributor. The load power factors refer to the voltage at far end.

ii. A single phase distributor 2km long supplies a load of 120A at 0.8p.f. lagging at its far end and a load of 80A at 0.9 p.f. lag at its mid-point. Both power factors are referred to the voltage at the far end. The resistance and reactance per km (go and return) are 0.05ohms and 0.1ohm respectively. If the voltage at the far end is maintained at 230V; calculate i) voltage t the sending end and ii) phase angle between voltages at the two ends **(Nov 04)**

32. What are the different distribution systems for a.c. and d.c. give comparision.

33. Explain the advantages and difficulties with ring type feeders compare to

i. Radial feeders
ii. Feeder fed at both ends

34. What are the power losses in a.c. distribution how is it estimated approximately.

35. The feeder shown in the fig. is connected to a 250 Volts D.C. supply and has a loading as shown. The reistance of the line is 0.20 ohm/km. Determine the voltage drop, voltage at the far end and power loss.

36. A 3-phase star connected load is made of 3 impendences of 50/_ 25^0 /ph each and the load is supplied by a 3-phase, 4-wire primary feeder. The balance phase voltages at receiving end are

Determine

i. Phase currents each line
ii. Line to line voltages

iii. The total active and reactive power supplied to the load

37. Explain voltage drop computation based on load density.

38. i. Explain power estimation in distribution system.
ii. Explain the method to analyze distribution feeder cost.

39. A 3-phase radial feeder as voltage of 10.5kV at the receiving end, a total impedance of 5.25+j10.95ohm/ph and the load of 5 MW with a lagging power factor of 0.9. Determine the following.
i. 3-phase line to line and phase voltage at sending end
ii. Load angle
iii. % of voltage regulation

40. A single phase feeder circuit as total impedance 0.5 + j0.2 ohm V_r = 230V and I_r = 5/_ -30^0 A. Determine
i. P.f. of load
ii. Load p.f. for which impedance angle is maximum
iii. Derive the expression for load power factor for which the drop is maximum

41. A 3-phase distribution line has resistance and reactance per phase of 15 ohms, 20 ohms respectively. If the sending end voltage is 33kV and the regulation of the line is not to exceed 10%. Find the maximum power in kW which can be transmitted over the line. Find also the KVAR supplied by the line when delivering the maximum power.

42. An unbalanced 3-phase star connected load is connected to a balanced 3-phase 4-wire source. The impedances Z_a, Z_b and Z_c are given as 70/_ 30^0 , 84/_ -40^0 and 50/_ 35^0 ohm/ph respectively. The voltage has an effective value of 11kV. Determine the following.
i. The line currents
ii. Total power deliver to the load

43. Let point 'A' and 'B' be connected to 250V DC supply. The length of the feeders are AD = 50m, DE=150m, EB=400m, BC=100m and CA=200m. The resistance per km = 0.2 ohm. Determine the minimum voltage point.

44. A single phase 230V line has a uniform loading of 700w/100m and one load of 5 kVA at 0.8 pf lag as shown in the fig. Determine the voltage drop and voltage at end og the line. Impedance per 100m length is 0.14+j0.105 and total line length = 1 km.

45. A 400 volts 3-phase 4-wire system has balanced loads and is fed from a 11KV/ 415 volts, 3-ph, 100kVA transformer. Determine the VD output kVA, kW and p.f. of the transformer.

UNIT-V

1. i) Discuss the procedure for fault current calculation in following faults:
a) Double Line-Ground fault. b) Line - Line fault
ii) Explain the principle of operation of fuse **(May 13)**

2. i) What are automatic line sectionalizers? Explain the purpose and advantages of using them.

ii) What is the main objective of distribution system protection? Explain in detail. **(Dec 12(R07))**

3. A single phase 3 wire distribution line 120 V - 0 - 120 V, feeds a load of 10 KVA line to line and 3 KVA on each line to ground. The transformer is 7620V/240V 25KVA with 5% impedance. The line impedance is j0.05 ohm per wire. Calculate the fault current and fault MVA for:
i. L-L fault 1km from the transformer
ii. L-G fault 1km from the transformer. **(May 11)**

4. i. What are the objectives of Distribution system protection. **(May 11, Nov 09, 08)**
ii. What is the data required for selecting a protective device.

5. Explain different types of over current protective devices with neat diagrams? **(May 11)**

6. Describe the principle of operation of:
   i. fuses
   ii. Circuit breakers
   iii. Line sectionalizer
   iv. circuit recloser. **(May 11, 09, Nov 09, 08)**

7. What are the various factors considered while selecting a over current protective device. Explain the operation of circuit recloser and circuit breaker. **(Nov 10)**

8. What are the common types of faults in a single phase 2-wire and 3-wire systems. Explain how fault current is computed with proper single line diagrams. **(Nov 10)**

9. A single phase 3 wire distribution line 600 V - 0 - 160 V, feeds a load of 10 KVA line to line and 3 KVA on each line to ground. The transformer is 7620V/240V 25kva with 5% impedance. The line impedance is j0.15 ohm per wire. Calculate the fault current and fault MVA for: **(Nov 10)**
   i. L-L fault 1km from the transformer
   ii. L-G fault 1km from the transformer.

10 . i. Discuss the procedure for fault current calculation in following faults:
   a. 3-phase fault.
   b. Single Line-Ground fault
   ii. Explain about the operation of a circuit breaker. **(Nov 10, 08)**

11. Explain different types of faults that occur in distribution system and their probability. Explain the procedure for calculation of fault current in L-L fault. **(Nov 09)**

12. What are the different types of over current protective device and explain their merits and demerits. **(Nov 09)**

13. What are the advantages and disadvantages of fuses. **(Nov 08)**

14. Explain the construction principle of operation of circuit breakers employed for distribution systems. **(Nov, May 09)**

15. What are the types of common faults that occur in a distribution system? Explain them with proper line diagram. **(Nov 09, 06, 05, Feb 08, May 05)**

16. i. Explain briefly secondary system fault current calculation for
   a. single phase 120/240V three wire secondary service
   b. Three phase 240/120 star/delta or delta/delta four wire secondary.
   ii. Explain the fault calculations involved in the following type of faults.
   a. Three phase grounded or ungrounded fault.
   b. Phase to phase grounded fault. **(May 09)**

17. i. What are the objectives of distribution system protection.
   ii. Explain in detail about line sectionalizers.
   iii. Explain the principle of operation of circuit breakers employed for distribution systems. **(May 09)**

18. Explain about the operation of a Fuse. **(May 09, Nov 08)**

19. i. What are the main objectives of distribution protection? Discuss.
   ii. The per unit values of positive, negative and zero sequence reactances of a network at fault are 0.08, 0.07 and 0.05 respectively. Determine the fault current if the fault is double line to ground. **(May 09, 04, Nov, Feb 08, 07, 06, 05)**

20. Explain the principle of operation of fuses. **(May 09, Nov 05, 04)**

21. Considering a typical example, describe the procedure for fault current calculations in a distribution system, mentioning the assumptions to be made for the analysis. **(May 09, 05, Feb 08, Nov 06, 05)**
22. Explain the principle of operation of line sectionalizer. **(Nov, Feb 08)**
23. What are the over current protective devices applied to distribution systems? Explain any one. **(Nov 08)**
24. Explain the principle of operation of circuit Re closure. **(Nov, Feb 08, 07)**
25. What are the different protective devices used in the distribution system? Give comparision between them.
26. What are the different varieties of fuses used of protection? Give the features of a HRC fuse and discuss its main advantages.
27. Give the diagram of an earth fault relay and discuss its function.
28. Explain the principle of a sectionaliser. How is it coordinated with a fuse.
29. What are the different protection schemes for feeder? Explain briefly?
30. What is the distance protection in feeders? Explain the scheme using an impedance relay.
31. How are feeder lines and transformers protected against over voltages or surge?
32. Explain how spark gaps can be used for protection of transformers and bushings against over voltages.
33. What is a surge diverter? Explain its protection.
34. How does a surge diverter (Lightning arrester) limits the over voltage and diverts surge currents.
35. Write the principle of various protective devices and advantages and disadvantages of fuse.
36. The per unit values of positive, negative and zero sequence reactances of a network at fault or 0.08, 0.07 and 0.06 respectively determine the fault current if the fault is double line to ground.

UNIT-VI

1. i) Explain the salient points in general co-ordination procedure.
   ii) Explain Fuse-Circuit breaker coordination **(May 13)**

2..i) What is the need for coordination ? Explain in detail.

ii) Explain the overall coordination procedure employed for protection of distribution system **(Dec 12(R07))**

3. what is meant by insulation co-ordination? How are the protective devices chosen for optimal insulation level in a power system? **(Dec 12)**
4. Explain Fuse-Fuse coordination. **(May 11, Nov 10, 09, 08)**
5. Explain Recloser -Recloser coordination. **(May 11, Nov 09, 08)**
6. Explain Fuse-Circuit breaker coordination. **(May 11, Nov 10, 09, 08)**
7. Explain Recloser- Circuit breaker coordination. **(May 11, Nov 08)**

8. Explain the salient points in general co-ordination procedure. **(May 11, Nov 08)**

9. Explain different types of coordination of protective devices. **(Nov 10)**

10. Explain general coordination procedure? Explain different types of coordination of protective devices. **(Nov 10)**

11. i. Discuss the procedure for fault current calculation in following faults:
    a. 3-phase fault.
    b. Single Line-Ground fault
    ii. Explain about the operation of a circuit breaker. **(Nov 10)**

12. Explain salient features in general co-ordination procedure between different protective devices. **(Nov 09)**

13. What is meant by co-ordination of protective devices? Explain it with a suitable example. **(Nov 09)**

14. Write improtance of general coordination. **(May 09)**

15. i. Explain in detail how the co- ordination of various protective devices helps in improving system performance.
    ii. List out the fault calculations involved in any two types of faults which occur in istribution System. **(May 09)**

16. i. What is the need for coordination ? Explain in detail.
    ii. Explain the overall coordination procedure employed for protection of distribution systems. **(May 09)**

17. Explain Fuse-Recloser coordination. **(Nov 08)**

18. What is the data required for the general coordination procedure? **(Nov 08)**

19. Explain the coordination procedure between Reclosure and fuse. **(Nov 05)**

20. How is the coordination between main fuse and sectional fuse achieved?

UNIT-VII

1. i) What is the justification for power factor improvement and what are the benefits.
   ii) A 3-phase,50Hz, 2200V induction motor develops 400H.P at a power factor 0.8lag and effciency 90% .The power factor is to be raised to unity by connecting a bank of condensers in delta across supply mains. If each of the capacitance unit built up of 4 similar 550V condensers, calculate the required capacitance of each condenser and its KVA rating **(May 13)**

2. i) Write short note an power factor correction.

   ii) Explain the practical procedure to determine the Best capacitor location. **(Dec 12(R07))**

3. i) List and explain any four disadvantages of low power factor.

   ii) Compare the merits and demerits of various methods of power factor improvement methods**.(Dec 12)**

4. i. Compare and explain the role of shunt and series capacitors in P.F. correction.
   ii. A 400V, 50 cycles three phase line delivers 207KW at 0.8p.f. (lag). It is desired to bring the line p.f. to unity by installing shunt capacitors. Calculate the capacitance if they are
   a. star connected
   b. delta connected. **(May 11, Nov 10, 06, 05, Feb 08, 07)**

5. A 37.3KW induction motor has a p.f 0.9 and efficiency 0.9 at full load , power factor 0.6 and efficiency 0.7 at half load. At no load, the current is 25% of the full load current and p.f 0.1. capacitors are supplied to make the line power factor 0.8 at half load. With these capacitors in circuit , Find the line power factor at :
   i. Full load and
   ii. no load **(May 11)**

6. Explain how reduction in line current and hence power losses are obtained with p.f. improvement. **(May 11)**

7. A 3-phase,50Hz, 2200V induction motor develops 400H.P at a power factor 0.8lag and efficiency 90% .The power factor is to be raised to unity by connecting a bank of condensers in delta across supply mains. If each of the capacitance unit built up of 4 similar 550V condensers, calculate the required capacitance of each condenser and its KVA rating. **(May 11)**

8. i. Explain power factors?
   ii. What is the justification for p.f. improve and what are the benefits? **(May 11)**

9. Discuss the basic features of applicapability of compensation through shunt and series capacitors in radial distribution systems. **(Nov 10)**

10. i. How is economical power factor arrived at for a given distribution system with different loads?
    ii. Explain shunt capacitors compensation. **(Nov 10)**

11. A 3-phase transformer rated 7000KVA and has a over load capability of 125% of the rating. If the connected load is 1150KVA with a 0.8 pf (lag), determine the following :
    i. The KVAR rating of shunt capacitor bank required to decrease the KVA load of the transformer to its capability level
    ii. the p.f. of the corrected level,
    iii. the KVAR rating of the shunt capacitor bank required to correct the load p.f. to unity. **(Nov 10, Feb 08, 06, 05, May 05)**

12. Explain the procedure to determine the best capacitor location. **(Nov, May 09)**

13. Explain the need for p.f. improvement in distribution on systems. **(Nov 09)**

14. i. Explain in detail the shunt compensation and the procedure to determine the best location of capacitor?
    ii. A 750 KVA load has a power factor of 0.75 lagging. It is derived to improve the power factor to 0.9 lagging. Find the KVAR rating of the capacitor for the power factor improvement? **(Nov 09)**

15. i. Why the power factor compensation is needed in power system.
    ii. Explain the procedure to determine the best location of capacitor. **(Nov 09)**

16. i. Compare shunt and series capacitor schemes of compensation.
    ii. A synchronous motor having a power consumption of 40 KW is connected with a load of 150KW, a lagging p.f of 0.8. If the combined load has a power factor of 0.9, what is the leading reactive KVA supplied by the motor and at what p.f is it working. **(Nov 09)**

17. i. Explain the importance of power factor correction?
    ii. Explain how a series capacitor boosts the voltage with the help of a phasor diagram? What are the drawbacks of this method? **(Nov 09)**

18. i. Explain the effect of shunt compensation on distribution system.
    ii. A 3-phase substation transformer has a name plate rating of 7250KVA and a thermal capability of 120% of the name plate rating. If the connected load is 8816KVA with a 0.85pf lagging p.f., determine the following:
    a. The KVAR rating of the shunt capacitor bank required to decrease the KVA load of the transformer to its capability level.
    b. The power factor of the corrected level. **(May 09, 04, Nov, Feb 08, 07, 06)**

19. i. Write short notes on comparisons of series and shunt compensation.
    ii. How do you determine the best capacitor location? Explain. **(May 09)**

20. Write short notes on power factor correction. **(May 09)**

21. Write detailed notes on the following:
    i. Loss reduction due to capacitor compensation.
    ii. With the help of a phasor diagram, show how a series capacitor boosts the voltage? What are the drawbacks of this method? **(Nov 08)**

22. i. Write notes on need for maintaining good voltage profile in power systems and need to improve power factor.
    ii. 3-Phase, 500H.P, 50Hz, 11KV star connected induction motor has a full load efficiency of 85% at lagging p.f of 0.75and is connected to a feeder. If it is desired to correct the p.f of 0.9 lagging load, determine the:
    a. The size of the capacitor bank in KVAR.
    b. The capacitance of each unit if the capacitors are connect in delta as well as star. **(Nov 08)**

23. i. Write notes on how an over excited synchronous machine improves power factor?
    ii. A feeder supplies an industrial consumer with a cumulative load of
    a. Induction Motors totaling 300HP which runs at an average efficiency of 89%and lagging average p.f. of 0.85
    b. Synchronous Motors totaling 100HP with an average efficiency of 86%and
    c. a heating load of 100KW. The industrial consumer plans to use the synchronous motors to correct its overall p.f. Determine the required p.f. of the synchronous motors to correct the overall p.f. at peak load to A. unity B. 0.96 lagging. **(Feb 08, 07, Nov 05)**

24. i. Explain the computerized method to determine the economic power factor.
    ii. A feeder supplies an industrial consumer with a cumulative load of
    a. Induction Motors totaling 200HP which runs at an average efficiency of 89%and lagging average p.f. of 0.85
    b. Synchronous Motors totaling 100HP with an average efficiency of 85%and
    c. a heating load of 100KW. The industrial consumer plans to use the synchronous motors to correct its overall p.f. Determine the required p.f. of the synchronous motors to correct the overall p.f. at peak load to A. unity B. 0.95 lagging. **(Feb07, Nov 05)**

25. How do the shunt capacitor and reactors control the voltage? List the disadvantages of using a shunt capacitor for voltage control. **(Nov 05)**

26. A 50 HP, 50Hz, 415V, delta connected induction motor has a full load efficiency of 0.85 and power factor 0.75. The power factor is to be improved to 0.9 using static capacitors. Determine
    i. Rating of capacitor bank
    ii. Capacitance of each unit if they are connected as
    a. delta b. star

27. A 33 KV feeder has (0.1 + j0.25)ohm impedance per phase per km and is supplying a load of 6 MVA over a distance of 80 km at 0.75 p.f. What will be the receiving end voltage and voltage drop of the line if compensated to 50% by series capacitance compensation? Find the receiving end voltage and improvement in voltage.

28. An industrial plant has 300 hp induction motor load that runs at 0.8 p.f. lagging and efficiency 0.85. A synchronous motor of 150 hp and an average efficiency 86% is available. If the motor is run on no load with same losses, determine the p.f. of the motor, to make the over all power factor of the plant to 0.9. Can the p.f. of the plant be raised to u.p.f.? If so what will the kVA intake of synchronous motors?

29. A 33 kV feeder has 0.1+j0.25 ohm impedance/phase/km and is supplying a load of 6 MVA.

30. How in the capacitor bank ratings obtained when the load p.f. is to be improved from $\cos\theta_1$ to $\cos\theta_2$?

31. Whar are the different locations for p.f. improvement capacitors? Discuss their relative advantages & disadvantages.

32. How does p.f. improvement help in reduction in %VD and hence voltage regulation of distribution transformers. With transformer of 6% reactance and 2% magnetizing current, what will be the probable ratings of capacitor bank to compensate for magnetizing current and improve regulation by 2%.

33. What is ferro-resonance? Explain the phenomenon and how it occurs with capacitance compensated lines.

34. Write short note on fixed and switched capacitors.

35. Explain economic justification of capacitor.

UNIT-VIII

1. Define:
   a. Voltage Regulation
   b. Voltage drop
   c. Nominal voltage
   d. Rated voltage.
   ii) Explain about step type regulators **(May 13)**

2. i) How an AVB Can control voltage ? With the aid of suitable diagram its function.
   ii) Explain the methods to calculate the voltage dips due to voltage fluctuations in distribution systems**.(Dec 12(R07))**
3. Why is voltage control required in power system? Mention the different methods of voltage control employed in a power system. Explain one method of voltage control in detail giving a neat connection diagram**.(Dec 12)**

4. i. Explain the basic function of booster transformer and how it increases the line voltage.
   ii. Describe the operation of AVR/AVB with neat diagram. **(May 11)**

5. i. Define:
   a. Voltage Regulation
   b. Voltage drop
   c. Nominal voltage
   d. Rated voltage
   ii. Explain about step type regulators. **(May 11)**

6. i. Define:
   a.Voltage Regulation
   b. Voltage drop
   c. Nominal voltage
   d. Rated voltage
   e. Utilization voltage
   f. Maximum voltage
   g. Minimum voltage
   h. Voltage spread.
   ii. Describe different types of equipment for voltage control with neat diagrams. **(May 11)**

7. Explain the line drop compensation on voltage control. **(May 11, Nov 10)**

8. Explain control and rating of voltage regulators. **(Nov 10)**

9. i. Briefly explain the line drop compensation and voltage control.
   ii. How an AVB can control voltage? With the aid of suitable diagram explain its Function.
   (Nov 10, 09, May 09, 05, Feb 08, 07, 06, 05,)
10. i. Explain the use of induction regulator and voltage control.
    ii. Discuss the effect of series capacitors on voltage control. **(Nov 10)**
11. i. Write short notes on any two methods of voltage control?
    ii. Voltage control and p.f. correction are necessary in power systems? Explain. What are the disadvantages of low voltage and low p.f. of the system? **(Nov 10, 08, 07, Feb 07, Nov 06, 05)**

12. What is series capacitor compensation in feeder lines? How does it improve the regulation of the lines. Discuss with suitable examples. **(Nov 09)**

13. Explain different methods of voltage control in power system with neat diagrams. **(Nov 09)**

14. i. What is series capacitors compensation in voltage in feeder lines? How does it improve the regulation of the lines?
    ii. Explain about the Induction type regulator. **(Nov 09)**

15. i. Explain the operation of AVR/ AVB with neat diagram.
    ii. Why do we need to control the voltage of a power system? Explain in detail? **(Nov 09)**

16. Write short notes on:
    a. Power factor correction b. Effect of AVB/AVR c. Line drop compensation **(May 09)**

17. i. How an AVR can control voltage? With the aid of suitable diagram explain its function.
    ii. Briefly explain about line drop compensation. **(May 09)**

18. What are the different methods for voltage control? Briefly explain them. **(May 09)**

19. Write the ways to improve the distribution system overall voltage regulation? **(Nov 08)**

20 . i. Why we need to control the voltage of power system? Explain in detail.
    ii. Compare and explain the role of shunt and series capacitor in voltage control.
    (Feb 08, Nov 07, 06, 05, May 04)

21. With the help of a phasor diagram, show how a series capacitor boosts the voltage? What are the drawbacks of this method? **(Feb 08, 07, Nov 05)**

22. Discuss how voltage profile of a long feeder can be improved by connecting shunt capacitor banks at the end of the feeders.

23. What is a line drop compensator? How is it used along with tap changer of transformer for voltage control?

24. Discuss the different components of distribution system that require optimization.

25. How do the shunt capacitor and reactors control the voltage.

26. List the disadvantages of using a shunt capacitor for voltage control.

27. Explain calculation of power factor correction.

28. Define nominal voltage, rated voltage, service voltage, base voltage, voltage spread, voltage regulation.

29. What is the main in voltage control. What are the methods adopted.

30. Explain about transformer tap changing method in voltage control.

31. A 33kV/ 11kV 5MVA substation has two 3 MVA transformers with impedance 0.025+j0.06 p.u. There are four feeder lines of length 15 km each with uniformly distributed load of 50 kVA/km and a concentrated load of 0.5 MVA at feeder end. If the voltage is to be maintained at 11 kV at feeder end.
    i. What is the voltage boost needed at substation?
    ii. The transformer has taps of 2% of normal voltage. What is the tap setting to be used? Line impedance is 0.8 + j0.6 ohm/km and load p.f. may be taken as 0.8 lag.