Code No: RT32024 **R13** SET - 1

III B. Tech II Semester Regular Examinations, April - 2016

POWER SYSTEM ANALYSIS

(Electrical and Electronics Engineering)

Time: 3 hours Maximum Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1 a) What is one line diagram? How the power system components are represented for it? [3M]
b) What is the need for load flow study? [4M]
c) What is bus impedance matrix? Mention its importance. [4M]
d) What is the need for short circuit study (or) fault analysis? [3M]
e) What are sequence impedances and sequence networks? [4M]
f) Distinguish between steady state and transient stability. [4M]

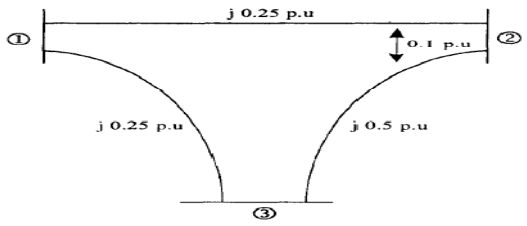
PART –B

2 a) Show that the per unit equivalent impedence of a two winding transformer is the same whether the calculations is made from H.V. side or the L.V. side. [8M]

b) What are the advantages of Y_{bus} over Z_{bus}? [8M]

3 a) What are the works involved in a load flow study? [3M]
b) With the help of a neat flow chart, explain the Newton-Raphson method of load flow solution when the system contains voltage controlled busses in addition to swing bus and load bus. [8M]
c) Compare G-S method and N- R methods of load flow solutions. [5M]

4 a) Compute the bus impedance matrix for the system shown in figure below by adding element by element. Take bus (2) as reference bus. [9M]



b) Explain the modifications necessary in the Z_{BUS} when a mutually coupled element is removed or its impedance is changed. [7M]

5 a) A-3-phase, 25 MVA, 11 KV alternator has internal reactance of 6%. Find the external reactance per phase to be connected in series with the alternator so that steady state short circuit current does not exceed six times the full load current. [8M]
b) Explain the procedure for making short circuit studies of a large power system using digital computer. Illustrate the answer by considering a symmetrical fault. [8M]

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6 a) What are the various types of faults? Discuss their frequency of occurrence and severity? Find the fault current when an L-L-G fault occurs at the terminals of an unloaded generator. [9M]

b) Derive an expression for the positive sequence current I_{a1} of an unloaded generator when it is subjected to a double line to ground fault. [7M]

7 a) Explain critical clearing time and critical clearing angle, deriving the expressions. [8M]

b) Describe the methods of improving transient stability. [8M]

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PART –A

1 a) What is the advantage of per unit method over percent method? [3M]

b) What are the information's that are obtained from a load flow study? [4M]

c) Write the four ways of adding impedance to an existing system so as to modify bus impedance matrix. [4M]

d) What are the methods used for reducing short circuit current. [3M]

e) Define negative sequence and zero sequence components. [4M]

f) Define transient stability limit and steady state stability limit. [4M]

PART –B

2 a) Form Y_{bus} for the network by direct inspection method: [8M]

Element	5-1	5-2	1-2	2-3	1-4	3-6	4-6
Positive sequence reactance	0.04	0.05	0.04	0.03	0.02	0.07	0.10

b) Consider the system shown in Figure 1. Selecting 10,000 KVA and 110 KV as base values, find the p.u. impedance of the 200 ohm load referred to 110 KV side and 55 kV side. [8M]

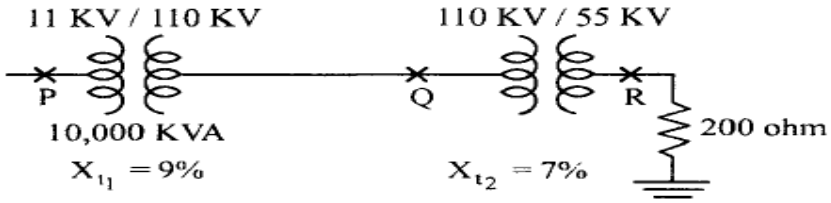

Figure 1

3 a) Define voltage controlled bus (generator bus/PV bus). [3M]

b) Explain the step by step computational procedure for the Newton-Raphson method of load flow studies. [8M]

c) Mention (any) three advantages of N-R method over G-S method. [5M]

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4 Using the building algorithm construct Z_{BUS} for the system shown in figure 2. [16M]
Choose 4 as reference bus.

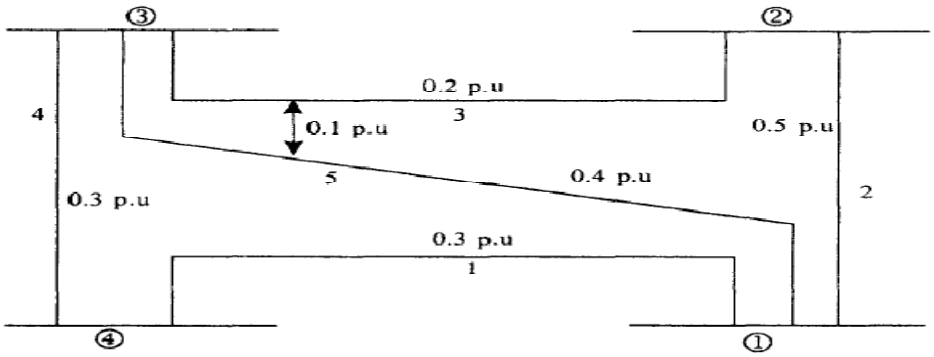

Figure 2

5 A 3-phase line operating at 11 KV and having a resistance of 1.5 ohm and reactance of 6 ohm is connected to a generating station bus bars through a 5 MVA step-up transformer having reactance of 5%. The bus bars are supplied by a 12 MVA generator having 25% reactance. Calculate the short circuit KVA fed into a symmetric fault [16M]
(i) at the load end of the transformer and
(ii) at the H.V. terminals of the transformer.

6 a) What are symmetrical components? Explain the symmetrical component transformation. [8M]

b) What is meant by sequence impedance? Explain the sequence network of an unloaded generator. [8M]

7 a) State and explain equal area criterion. How do you apply equal area criterion to find the maximum additional load. [8M]

b) What is meant by swing curve and how is it determined? What information is supplied by it? [8M]

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PART –A

1 a) Define the per unit terms. [3M]

b) What are the different types of buses in a power system? [4M]

c) What is the need of Z_{bus} building algorithm? [4M]

d) What are the assumptions made in short circuit studies of large power system network. [3M]

e) Write the symmetrical components of three phase system. [4M]

f) Define the dynamic stability and transient stability. [4M]

PART –B

2 a) Obtain the per unit representation for the three-phase power system shown in figure 1 [8M]

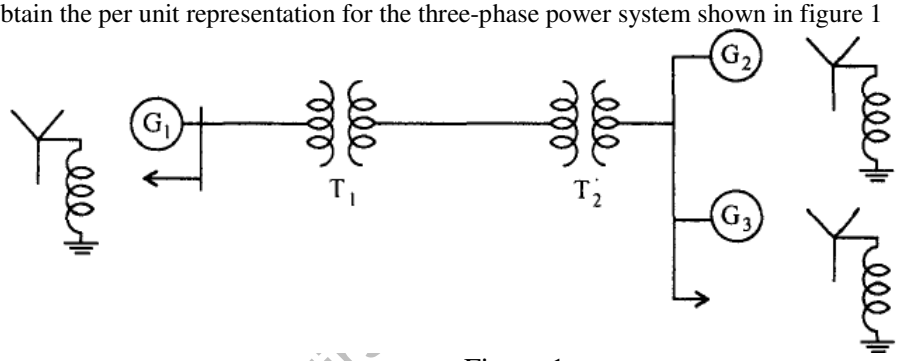

Figure 1

Generator 1 : 50 MVA; 10.5 KV; X = 1.8 ohm
Generator 2 : 25 MVA; 6.6 KV; X = 1.2 ohm
Generator 3 : 35 MVA; 6.6 KV; X = 0.6 ohm
Transformer T_1 : 30 MVA; 11/66 KV; X = 15 ohm/phase
Transformer T_2 : 25 MVA; 66/6.2 KV, as h.v. side X = 12 ohms
Transmission line: X_L = 20 ohm/phase

b) Form Y_{bus} for the network by singular transformation: [8M]

Element	5-1	5-2	1-2	2-3	1-4	3-6	4-6
Positive sequence reactance	0.04	0.05	0.04	0.03	0.02	0.07	0.10

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3 a) What is swing bus (slack bus/reference bus)? [3M]

b) Explain the step by step computational procedure for the Gauss-Seidel method of load flow studies [8M]

c) What are the advantages of Newton-Raphson method? [5M]

4 Consider the diagram shown in figure 2. Obtain Z_{bus} by using Z_{bus} building algorithm. [16M]

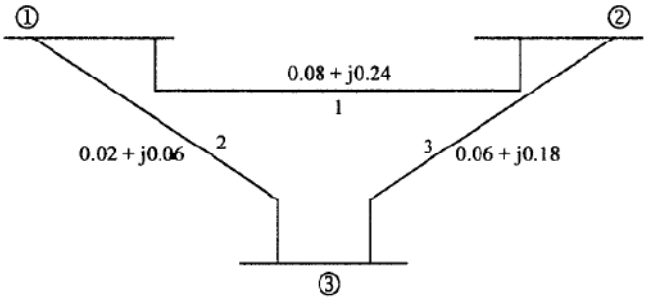

Figure 2

5 a) The short circuit MVA at the bus bars for a power plant A is 1200 MVA and for another plant B is 1000 MVA at 33 KV. If these two are to be interconnected by a tie-line with reactance 1.2 ohm. Determine the possible short circuit MVA at both the plants. [8M]

b) Explain the short circuit model of a synchronous machine under short circuit conditions. [8M]

6 a) A balanced 200 V, 3 phase supply feeds balanced resistive load as shown in figure 3. If the resistance R_{bc} is disconnected. Determine I_a, I_b and I_c and symmetrical components of I_a, I_b and I_c. [8M]

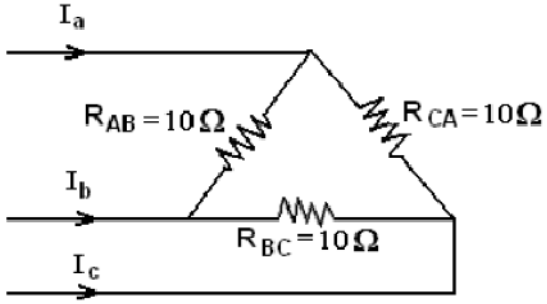

Figure 3

b) Derive the expression for power in terms of symmetrical components. [8M]

7 a) Explain the equal area criterion for the stability of an alternator supplying infinite bus via an inductor interconnector. [8M]

b) Discuss the various methods for improving steady state stability. [8M]

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PART –A

1 a) Give the formula to calculate base current and base impedance of a three phase system. [3M]

b) List the quantities specified and quantities to be determined from the load flow study for the various types of buses. [4M]

c) What are the advantages of bus impedance matrix? [4M]

d) List out the differences in representing the power system for load flow and short circuit studies. [3M]

e) What are symmetrical components? [4M]

f) What are the methods used for improving steady state stability? [4M]

PART –B

2 a) Explain the importance of per-unit system. [6M]

b) Determine the incidence matrices A, B, *B'*, C, *C'* and K. From that verify the following relations for the figure 1, take 1 as ground bus [10M]
(i) $C_b = -B_L^T$ (ii) $A_b K^T = U$

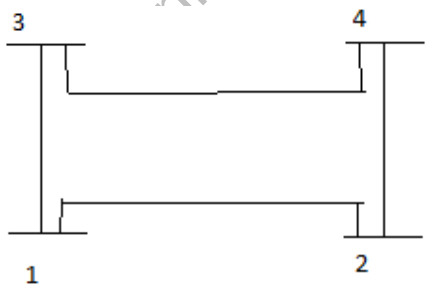

Figure 1

3 b) Derive the basic equations for the load flow study using Gauss-Seidel method. With respect to this method, explain the following: [8M]
i) Acceleration factor.
ii) Handling of PV buses.

c) What is Jacobian matrix? How the elements of Jacobian matrix are computed? [8M]

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4 a) Form bus impedance matrix for the data given below. [11M]

Element number	Bus code From bus – To bus	Self impedance
1	2-3	0.6 p.u.
2	1-3	0.5 p.u.
3	1-2	0.4 p.u.

b) Explain the procedure for modification of Z_{bus} when a line is added or removed which has no mutual reactance. [5M]

5 a) There are two generating stations each which an estimated short circuit KVA of 500,000 KVA and 600,000 KVA. Power is generated at 11 KV. If these two stations are interconnected through a reactor with a reactance of 0.4 ohm, what will be the short circuit KVA at each station? [8M]

b) What do you understand by short-circuit KVA? Explain. [8M]

6 a) Prove that a line to ground fault at the terminals for an alternator with solidly grounded neutral is more severe than a three phase fault. [8M]

b) Explain the zero sequence networks of transformers with diagrams. [8M]

7 a) Derive the swing equation for a single machine connected to infinite bus system. State the assumptions if any and state the usefulness of this equation. Neglect the damping. [8M]

b) Discuss the various factors affecting the transient stability of the system. [8M]

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