Hall Ticket No: | | | | | | | | | |          Code No: AEE012

**INSTITUTE OF AERONAUTICAL ENGINEERING**
**(Autonomous)**
**Dundigal, Hyderabad - 500 043**

MODEL QUESTION PAPER

III B.Tech II Semester End Examinations (Regular), May – 2020
**Regulation: IARE-R16**

**POWER SYSTEM ANALYSIS**

**ELECTRICAL AND ELECTRONICS ENGINEERING**

**Time: 3 hours**                                                                 **Max. Marks: 70**

**Answer ONE Question from each Unit**
**All Questions Carry Equal Marks**
**All parts of the question must be answered in one place only**

### UNIT – I

1.  a)  Explain clearly the procedure to form bus incidence matrix and deduce bus admittance matrix from bus incidence matrix.  [7M]

    b)  (a) Discuss the advantages of ZBUS building algorithm.  [7M]
        (b) Z bus matrix elements are given by Z11= 0.2, Z22= 0.6, Z12=0 find the modified ZBUS if a branch having an impedance 0.4 p.u. is added from the reference bus (Bus - 1) to new bus. Also find the modified ZBUS if a branch having an impedance 0.4 p.u. is added from existing bus (other than reference bus) to new bus.

2.  a)  Take example power system and Define a tree and co-tree. Write the Bus - Branch incidence matrix and use it to obtain YBUS. Select arbitrary directions.  [7M]

    b)  a) If the mutual coupling between the two elements of a power system network is v zero, then what are the off-diagonal elements of the $Z_{BUS}$ matrix? How do you decide the order of $Z_{BUS}$?  [7M]
        b) For the network shown in figure, with reactance values in p.u., obtain $Z_{BUS}$ by building algorithm. Take bus-3 as reference bus.
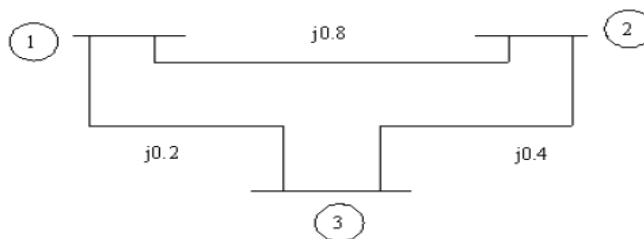


### UNIT – II

3.  a)  Classify various types of buses in a power system for load flow studies. Justify the classification. Prepare basic data require for load flow analysis.  [7M]

b) The data for 2-bus system is given below. [7M]
$S_{G1}$= Unknown; $S_{D1}$= Unknown ,$V_1$=1.0p.u. ; $S_1$= To be determined. $S_{G2}$=0.25+$jQ_{G2}$ p.u.; $S_{D2}$=1+j0.5 p.u. The two buses are connected by a transmission line p.u. reactance of 0.5 p.u. Find $Q_2$ and angle of $V_2$. Neglect shunts susceptance of the tie line. Assume |$V_2$|=1.0, perform two iterations using GS method.
If 200V is applied across plates, determine the voltage gradient and energy stored in each dielectric.

4. a) Write short notes on the following: [7M]
   a) Merits and demerits of numerical method for load flow.
   b) Merits and demerits of using polar and rectangular coordinates in load flow studies.
   c) Comparison between numerical methods between for load flow.

b) Line data: [7M]

| Bus Code | Admittance(p.u.) |
|----------|------------------|
| 1-2 | 1+j6 |
| 1-3 | 2-j3 |
| 2-3 | 0.8-j2.2 |
| 2-4 | 1.2-j2.3 |
| 3-4 | 2.1-j4.2 |

Load Data:

| Bus No. | P (p.u.) | Q (p.u.) | V (p.u.) | Remarks |
|---------|----------|----------|----------|---------|
| 1 | - | - | 1.03 | Slack |
| 2 | 0.52 | 0.23 | 1.0 | PQ |
| 3 | 0.42 | 0.32 | 1.0 | PQ |
| 4 | 0.4 | 0.12 | 1.0 | PQ |

Determine the voltages at all the buses at the end of first iteration using GS method.

## UNIT – III

5. a) A Three phase fault(not involving ground) occurs at bus p. Explain the method of finding fault current and fault voltages(voltage at Evaluate faculty bus and at healthy buses) in terms of symmetrical component quantities. [7M]

b) A single phase 9.6 kVA, 500 V / 1.5 kV transformers has an impedance of $1.302\ \Omega$ with respect to primary side. Find its per-unit impedance with respect to primary and secondary sides. [7M]

6. a) With the usual notation derive the equation of computation of sequence currents for a line to ground fault on an n bus power system using Z bus algorithm. [7M]

b) Derive expressions for fault Current at the buses and lines, Voltages at the faulted bus and at other buses when a single Line-to-ground fault occurs at a bus on conventional phase 'a', using fault impedance and Bus impedance matrices, in sequence component form. [7M]

## UNIT – IV

7. a) Distinguish between steady state, transient state and dynamic stability and Derive the expression for steady state stability limit using ABCD parameters. [7M]

b) Write short notes [7M]
   a) Transfer reactance
   b) Synchronizing power CLO-efficient.

8. a) Differentiate between steady state stability and transient state stability of power systems. Discuss the factors that affect these stabilities.   [7M]

   b) Derive an expression for steady state stability limit if the resistance and shunt capacitance of the transmission line are considered.   [7M]

## UNIT – V

9. a) Explain what is "swing Curve". Give its practical significance in stability analysis. Give the state variables for formation of swing equation.   [7M]

   b) What is the critical fault clearing angle and its effect upon the stability? Obtain an expression for the same. What are the factors that affect the transient stability? Explain in detail.   [7M]

10. a) Derive the expression for critical clearing angle for a synchronous machine connected to infinite bus system when a 3 phase fault occurs and it is cleared by opening of circuit breakers.   [7M]

   b) A 50 Hz, 4 pole turbo alternator rated 150 MVA, 11 KV has an inertia constant of 9MJ/MVA. Find the a) stored energy at synchronous speed b) the rotor acceleration if the input mechanical power is raised to 100 MW when the electrical load is 75 MW. C) The speed at the end of 10 cycles if acceleration is assumed constant at the initial value   [7M]

# INSTITUTE OF AERONAUTICAL ENGINEERING

## (Autonomous)

## COURSE OBJECTIVES:

**The course should enable the students to:**

| I | Determine the bus impedance and admittance matrices for power system network.. |
|---|---|
| II | Calculate various parameters at different buses using load flow studies and numerical methods. |
| III | Discuss the symmetrical Component theory, sequence networks, short circuit calculations and per unit representation power system. |
| IV | Understand the steady state stability of power system and suggest improvements |
| V | Analyze the transient stability of power system and check methods to improve the stability. |

## COURSE OOUTCOMES:

| I | Formulate the bus impedance and admittance matrices for complex power system networks. |
|---|---|
| II | Identify unknown electrical quantity at various buses of power system and estimate. |
| III | Determine effect of symmetrical and unsymmetrical faults on power system in per unit system. |
| IV | Check the effect of slow and gradual change in load on power system and check the methods of improvement. |
| V | Discuss the characteristics of power system under large disturbances and methods to improve transient stability. |

## COURSE LEARNING OUTCOMES:

**Students, who complete the course, will have demonstrated the ability to do the following:**

| AEE012.1 | Define the basic terminology of graph theory to form bus impedance and admittance matrices.. |
|---|---|
| AEE012.2 | Determine the bus impedance and admittance matrices for power system. |
| AEE012.3 | Draw the algorithms to form the bus impedance and admittance matrices for various configuration of primitive network. |
| AEE012.4 | Understand necessity of load flow studies and derive static load flow equations. |
| AEE012.5 | Use different numerical methods to determine unknown parameters at various buses and to draw relevant algorithms. |
| AEE012.6 | Compare various numerical methods of load flow studies and analyze DC load flow studies. |
| AEE012.7 | Draw the equivalent reactance network of three phase power system using per unit system. |
| AEE012.8 | Calculate the electrical parameters under symmetrical fault Conditions and understand symmetrical Component theory. |
| AEE012.9 | Compute the electrical parameters under unsymmetrical faults with and without fault impedance. |
| AEE012.10 | Discuss the steady state stability, dynamic stability and transient stability of power system. |
| AEE012.11 | Describe steady state stability power limit, transfer reactance, synchronizing power Coefficient, power angle curve. |
| AEE012.12 | Determination of steady state stability and methods to improve steady state stability of power system. |
| AEE012.13 | Derive the swing equation to study steady state stability of power system. |
| AEE012.14 | Predict the transient state stability of power system using equal area criteria and solution of swing equation. |
| AEE012.15 | Suggest the methods to improve transient stability, discuss application of auto reclosing and fast operating circuit breakers. |

**MAPPING OF MODEL QUESTION PAPER QUESTIONS TO THE ACHIEVEMENT OF CLOURSE OUTCLOMES**

| SEE QUESTION No | | | OUTCOMES | COURSE OUTCOMES | BLOOM TAXONOMY LEVELS |
|---|---|---|---|---|---|
| 1 | a | AEE012.2 | Determine the bus impedance and admittance matrices for power system. | CO 1 | Remember |
| | b | AEE012.3 | Draw the algorithms to form the bus impedance and admittance matrices for various configuration of primitive network. | CO 1 | Understand |
| 2 | a | AEE012.1 | Define the basic terminology of graph theory to form bus impedance and admittance matrices. | CO 1 | Remember |
| | b | AEE012.3 | Draw the algorithms to form the bus impedance and admittance matrices for various configuration of primitive network. | CO 1 | Understand |
| 3 | a | AEE012.4 | Understand necessity of load flow studies and derive static load flow equations. | CO 2 | Remember |
| | b | AEE012.5 | Use different numerical methods to determine unknown parameters at various buses and to draw relevant algorithms. | CO 2 | Understand |
| 4 | a | AEE012.6 | Compare various numerical methods of load flow studies and analyze DC load flow studies. | CO 2 | Remember |
| | b | AEE012.5 | Use different numerical methods to determine unknown parameters at various buses and to draw relevant algorithms. | CO 2 | Understand |
| 5 | a | AEE012.8 | Calculate the electrical parameters under symmetrical fault conditions and understand symmetrical component theory. | CO 3 | Understand |
| | b | AEE012.7 | Draw the equivalent reactance network of three phase power system using per unit system. | CO 3 | Understand |
| 6 | a | AEE012.8 | Calculate the electrical parameters under symmetrical fault conditions and understand symmetrical component theory. | CO 3 | Understand |
| | b | AEE012.9 | Compute the electrical parameters under unsymmetrical faults with and without fault impedance. | CO 3 | Understand |
| 7 | a | AEE012.10 | Discuss the steady state stability, dynamic stability and transient stability of power system. | CO 4 | Remember |
| | b | AEE012.11 | Describe steady state stability power limit, transfer reactance, synchronizing power coefficient, power angle curve. | CO 4 | Understand |
| 8 | a | AEE012.10 | Discuss the steady state stability, dynamic stability and transient stability of power system. | CO 4 | Understand |
| | b | AEE012.11 | Describe steady state stability power limit, transfer reactance, synchronizing power coefficient, power angle curve. | CO 4 | Understand |
| 9 | a | AEE012.13 | Derive the swing equation to study steady state stability of power system. | CO 5 | Remember |
| | b | AEE012.14 | Predict the transient state stability of power system using equal area criteria and solution of swing equation. | CO 5 | Understand |
| 10 | a | AEE012.14 | Predict the transient state stability of power system using equal area criteria and solution of swing equation. | CO 5 | Understand |
| | b | AEE012.15 | Suggest the methods to improve transient stability, discuss application of auto reclosing and fast operating circuit breakers. | CO 5 | Understand |

**Signature of Course Coordinator**                                                                 **HOD, EEE**