Ref.: EX/EE/5/T/512E/2018(OLD)

B.E. ELECTRICAL. ENGG.(PART TIME) 5TH YEAR 1ST SEMESTER EXAMINATION 2018(OLD)

ADVANCED POWER SYSTEM ANALYSIS

Time: Three hours Full Marks: 100

(50 marks for each part)
Use separate answer script for each part.
PART I
Answer **any two** questions.
Figures in the margin indicate full marks
All the symbols used have their usual meaning

1.(a) Explain with necessary justification how synchronous generators and loads are modeled in classical transient stability study. Also explain why and how loadflow equations are modified for such study. (10)

(b) With the help of a neat vector diagram show the relation between the internal and terminal voltages and currents of the flux decay model of a synchronous machine and write down the differential and algebraic equation (DAE) model of the machine. (7)

(c) From the following data for a 50Hz power system, calculate the initial values for all the variables required for transient stability study. (8)

Prefault operating condition data for the machine:

$V = 1.025\angle 9.3^0$, $P = 1.63$, $Q = 0.062$

Machine parameter data: $x_d = 0.8958,\ x_d' = 0.1198,\ x_q = 0.8645$

Exciter data: $K_A = 20,\ T_A = 0.2,\ K_E = 1.0,\ T_E = 0.314,\ K_F = 0.063,\ T_F = 0.35$,

$$S_E\left(E_{fd}\right) = 0.0035e^{1.555E_{fd}}$$

All the above data are in p.u. except T_A, T_E and T_F which are in seconds.

2.(a) With the help of a neat sketch show the transfer function block diagram of the IEEE-Type I model of synchronous machine excitation system. Mention the significance of all the blocks and derive the differential equation model for the above model of excitation system. (8)

(b) Explain the advantages of using sequence component quantities over phase quantities for analysis of unbalancedly loaded power system. Derive the general equation for fault current in a power system in sequence component quantities when fault impedance matrix is available and when not. (17)

3. (a) Derive the fault impedance matrix or fault admittance matrix (whichever is applicable) in sequence quantities for a 3-phase to ground fault in a power system. (5)

With necessary derivation show how an existing Z_{bus} is augmented for each of the following connections. (20)

i) An existing bus is connected to a new bus through a branch having an impedance z_b

ii) A new bus is connected to the reference bus through a branch having an impedance z_b .

B.E. Electrical Engineering (Part Time), 2018

(5th Year, *1st* Semester).

Advanced Power System Analysis

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(50 marks for each part)

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PART-II

Answer *any three* questions from this part.

Two marks are reserved for neat and well organised answer

1. a) With the help of a flowchart explain the solution algorithm of the load flow problem using the Newton-Raphson method. 12
   b) Compare the Newton-Raphson and Fast Decoupled methods. 4

2. a) Discuss the importance of the load flow problem in power system. 4
   b) Why load flow problem has to be solved using some iterative technique? 3
   c) Why a 'Slack bus' is necessary for the solution of the load flow problem? 4
   d) Derive expression for the bus voltages of a Power System using Gaus-Seidel load flow. 5

3. a) Derive expression for the transmission loss in terms of active power output of the generators. State and justify the assumptions made. 6+4
   b) In the Power System shown in Fig.P3 when 100 MW is delivered by Generator-1 a loss of 10 MW takes place in the line connecting Bus-1 and Bus-3. When 100 MW is delivered by Generator -2, a loss of 12v MW takes place in the line connecting Bus-2 and Bus 3. Determine the loss coefficients. If the Power delivered by Generator-1 and Generator-2 are 170MW and 220 MW respectively, determine the MW consumed by the load. 6

   8

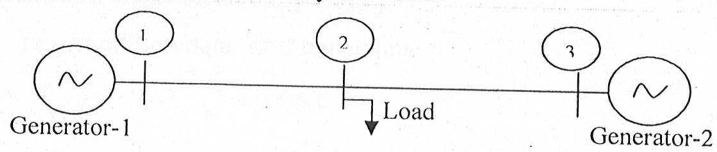

Fig.- P3

4. a) Derive expression for the Economic Generation schedule of the generators of a power system. Explain the term 'Penalty factor' in this connection. 7 3
   b) Explain the solution algorithm of the Generation Scheduling problem. 6

5. a) Discuss about the different costs to be considered while solving the Unit Commitment problem. 6
   b) Discuss the importance of Spinning reserve constraint and minimum up and down time constraints in the context of the Unit Commitment problem. 3+2
   c) The fuel cost curves of three generators of a power system are: 5
   $F1= 300 + 40 P_1 + 0.07 P_1^2$ Rs/hour, $50 \leq P_1 \leq 400$ MW
   $F2= 200 + 35 P_2 + 0.15 P_2^2$ Rs/ hour, $100 \leq P_2 \leq 500$ MW
   $F3= 280 + 27 P_3 + 0.08 P_3^2$ Rs/hour, $50 \leq P_3 \leq 300$ MW
   Prepare a Unit Commitment schedule for the generators using the priority order approach.