Ref.: EX/EE/T/414E/2018

B. ELE. ENGG. 4TH YEAR 1ST SEMESTER EXAMINATION 2018

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) Write down the load flow equations in the form suitable for classical transient stability study. Also explain why this form is required to be used for such study? (8)

(b) Explain clearly why flux decay model of synchronous machine is preferred over classical (2nd order) model for transient stability study over a longer period. (5)

(c) 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. (6)

(d) From the following data for a 50Hz power system, calculate the initial values for all the variables required for transient stability study. Assume that excitation control is not present. (6)
Prefault operating condition data for the machine:

$V = 1.025\angle 4.7^0$, $P = 0.85$, $Q = -0.109$

Machine parameter data: $x_d = 1.3125$, $x_d^{/} = 0.1813$, $x_q = 1.2578$

All the above data are in p.u.

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 pertaining to the above representation of excitation system. (7)

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(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. There from derive the expression in phase quantities for fault current for a 3-phase to ground fault. Clearly mention the assumptions taken during this derivation. (18)

3.(a) For a double line fault in a power system derive the fault impedance matrix or fault admittance matrix (whichever is applicable) in sequence quantities. (5)

(b) The partial Z_{bus} of a power system is given by (20)

$$Z_{bus} = j\begin{bmatrix} 0.25 & 0 & 0 \\ 0 & 0.25 & 0.25 \\ 0 & 0.25 & 0.35 \end{bmatrix}$$

With necessary derivation obtain the new Z_{bus} for each of the following augmentations of the partial network.

i) Bus 1 is connected to a new bus through a branch having an impedance $j0.10$.

ii) Bus 3 is connected to the reference bus through a branch having an impedance $j0.20$.

All the above data are in p.u.

Bachelor of Electrical Engineering, 2018

(4th Year, *1st* Semester).

Advanced Power System Analysis

Time: Three Hours **Full Marks:** 100

(50 marks for each part)

Use a separate Answer-Script for each Part

PART-II

Answer *any three* questions from this part.

Two marks are reserved for neat and well organised answer

1.	a) State and justify the assumptions made in the formulation of Fast Decoupled load flow.	8
	b) With the help of a flowchart explain the solution steps of the Fast Decoupled load flow.	8
2.	Justify the following:	
	a) In the load flow problem buses having voltage control facilities are represented as P-V buses.	3
	b) For the P, Q buses initial values of voltage magnitude and phase angle for load flow iterations are assumed to be 1.0 p.u and 0° respectively.	3
	c) Explain, how the following buses may be represented for load flow:	
	i) Bus having a shunt capacitor.	3
	ii) Bus having a Synchronous condenser.	3
	d) Derive expression for the complex bus voltage suitable for Gaus- Seidel load flow.	4
3.	a) The fuel cost curves of the generators of a power system are as given below: $F1 = 550 + 8.2 P_1 + 0.00165 P_1^2$ $F2 = 400 + 8.96 P_2 + 0.0025 P_2^2$ $F3 = 160 + 9.2 P_3 + 0.00561 P_3^2$ F1, F2, F3 are in MBtu/ hour and P_1, P_2, P_3 are in MW. The generators are operating at their optimum generation schedule. An increase in load of 50 MW takes place. Determine the share of the generators using the base point and participation factor method.	6
	Also, discuss the situation when the method may be used in place of the full Economic Dispatch solution.	4
	b) 'In the Economic Dispatch problem the Lagrange multiplier λ represents the incremental cost of received power' -- justify.	6
4.	a) Explain the importance of the Unit Commitment problem in the operation of power systems having thermal generating units.	4
	b) How the Unit Commitment problem is different from the Economic Dispatch problem?	4
	c) Explain the priority order approach of solving the Unit Commitment problem. Also, discuss the shut down algorithm to be used along with the priority order approach.	4+4

5. a)The input-output curves of the generators of a power system are : 7

$$F1=320+3.6 P1 + 0.00141 P1^2$$
$$F2=400+ 3.93 P_2 +0.00194 P_2^2$$

The Loss-coefficients are : B11=0.002, B12=0.0005, B22=.003

If the system λ (Lagrange multiplier) is 9.2, determine the transmission loss and the load of the system. P1, P2 are the generator outputs in MW.

b) Following are the solutions of the Economic Dispatch problem of four thermal generating units of a power station for three different operating conditions. Discuss the steps to be performed to obtain the final solutions in these cases. The sum of the generation capacity of the generators are more than the loads on the system. 6

i) PG1 crosses its maximum limit, PG2 crosses its minimum limit, PG2 & PG3 are within their permissible limits.

ii) PG1, PG3 & PG4 are within their permissible capacity limits. PG2 crosses its minimum limit.

iii) PG1 and PG3 exceed their maximum permissible limits. PG2 and PG3 are within their permissible limits.

PG1, PG2, PG3 and PG4 are the generator outputs.

c) Define the term 'incremental transmission loss' and explain its effect on the Economic Dispatch. 3