Ref. No.: Ex/EE/PE/B/T/414E/2024

Bachelor of Electrical Engineering, 2024

4^{th} year 1^{st} Semester

Advanced Power System analysis

Time: 3 hours Full marks: 100

50 marks for each part

Use separate answer scripts for each part

Part-I

1. Answer question (a) and any two from (b), (c) and (d) [Marks: 12+ 5 x 2]

a) In connection with the load flow problem of the Power System shown in Fig.Q1

i)Identify the type of the buses with proper justifications

ii)Calculate the elements of the Jacobean matrix for the Newton-Raphson or Fast Decoupled load flow.

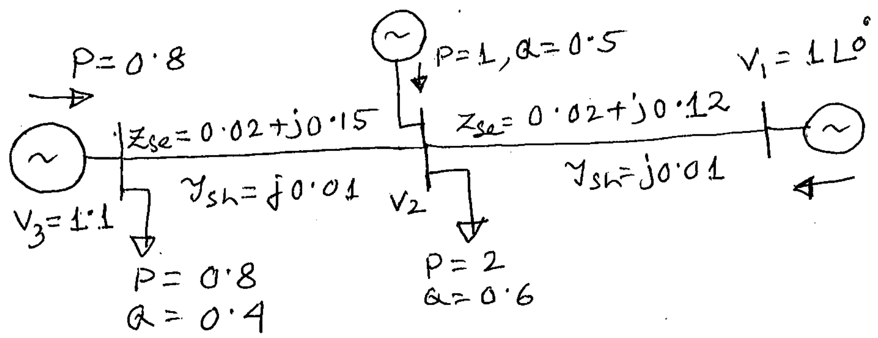

Fig. Q1.

All data are in per unit.

b) How the load flow equations are made decoupled in Fast Decoupled load flow?

c) How the tap changing transformers, phase shifters and shunt capacitors are treated in the formulation of the Fast Decoupled load flow?

d) How the simultaneous convergence of the load flow equations is ensured in the solution algorithm of Fast Decoupled load flow?

2. Answer question (a) and any two from (b), (c) and (d) [Marks: 10+ 5x2]

a) i) The Input-output curves of three generators are:

$F1=520+8.3\ P1+0.00125\ P_1^2$

$F2=500+8.7\ P_2+0.0025\ P_2^2$

$F3=400+9.1\ P_3+0.0050P_3^2$

[Turn over

P_1, P_2 and P_3 are active power outputs in MW, maximum and minimum value for each being 200 MW and 50 MW respectively and F1, F2, F3 are fuel inputs in MBtu per hour. Determine sharing of the generators for a demand of 500 MW.

ii) The generators in the system of Fig. P4 are having identical cost curves. The transmission lines between buses A-B and B-C are also identical in all respect. When the load at bus B is 50 MW, a transmission loss of 6 MW is measured. Determine the penalty factors. Also comment on the changes in the values of the penalty factors when the lengh of section AB is not equal to that of BC.

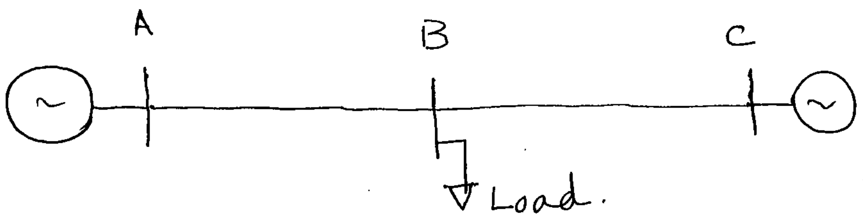

Fig. Q.2

b) 'The Lagrange multiplier may be interpreted as the incremental cost of power demand' --justify.

c) .Derive the expression for participation factors and mention the condition when such factors may be used for solving the Economic Dispatch problem.

d)How various constraints are satisfied while the Unit Commitment problem is solved using the Priority order approach?

5. Answer either (a) or (b) [Marks: 8]

a) Consider the following cases of two- area load frequency control:

i) Area control error is formed as a combination of frequency and tie line power flow error.

ii) Area control error is defined to include the frequency error only.

Comment on the status of the steady state frequency and tie line power flow in the above cases.

b) Draw the Transfer function block diagram for the load frequency control of Two-area Power system assuming that the speed changer inputs are not changed following a change in the system demand.

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B.E. ELECTRICAL ENGINEERING FOURTH YEAR FIRST SEMESTER – 2024

Subject : ADVANCED POWER SYSTEMS ANALYSIS **Part II**

Time: 3 hr. **Full Marks: 100 (50 for this part)**

Use Separate Answer scripts for each part

Answer any two questions

1 (a). Mentioning the proper reasons discuss how the loads and the synchronous machines need to be modeled in classical transient stability. Also discuss the modifications required in GS load flow equations to accommodate the above models. 10

(b). Show the flow chart or write down the computational steps required to solve the classical transient stability problem using Modified Euler method. 15

2 (a). Properly explain the limitations of classical model of synchronous machine in long duration transient stability study. Which model do you suggest to overcome these limitations? Write down the differential equations for that model and also show, with the relevant vector diagram, the relations between the various voltages and currents describing the model. 10

(b). Show the transfer function block diagram of the IEEE Type I model of synchronous machine excitation system and develop the differential equation model of the same. 7

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

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. 8

(symbols have their usual significance)

3(a). Explain why sequence component quantities are preferred over phase quantities for analysis of power system with unbalanced loading. Derive the general equation for fault current in a power system in sequence component quantities when fault impedance matrix is available and when not. Hence derive the expression, in phase quantities, for fault current for a 3-phase to ground fault. Clearly mention the assumptions taken during this derivation. 15

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

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

With necessary derivation obtain the new Z_{bus} when bus 3 is connected to a new bus through a branch having an impedance j0.20. 10