TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2083 Baishakh

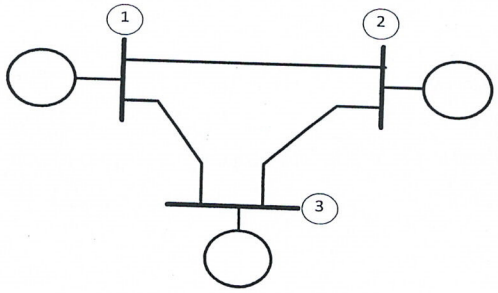
Exam.	Back (New Course)		
Level	BE	Full Marks	60
Programme	BEL	Pass Marks	24
Year / Part	II / II	Time	3 hrs.

Subject: - Power System Analysis II *(ENEE 252)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Using appropriate mathematical derivations, the phase angle (power/loading angle) δ between E_f and V_t is due solely to the real power delivered by the synchronous generator. [5]

   b) For the power system network shown below, obtain the bus admittance matrix. The series impedance and shunt half-charging admittance of each line are $0.05 + j0.15$ p.u. and $j0.03$ p.u. respectively. If a tap-changing transformer having turn ratio (t) = 1:1.05 is inserted mid-point between buses 1 and 2, find the modified bus admittance matrix. [3+4]



2. a) What are the buses are considered in the Newton-Raphson load flow analysis method? Specify and elaborate the characteristics of the buses. [2+3]

   b) The single line diagram of power system network is shown in the figure below. The Y bus of the system and bus data are shown in the table. (Use N-R method). [4+3]
   (i) Form the Jacobian Matrix.

   (ii) Find the unknown values after the first iteration.

$$\text{Ybus} = \begin{bmatrix} -j12 & j6 & j6 \\ j6 & -j12 & j6 \\ j6 & j6 & -j12 \end{bmatrix}$$

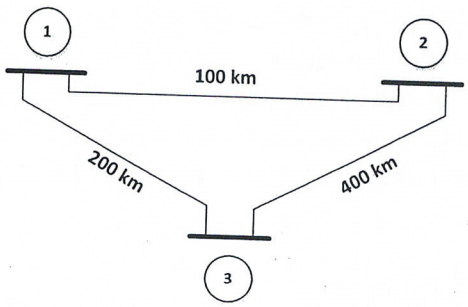
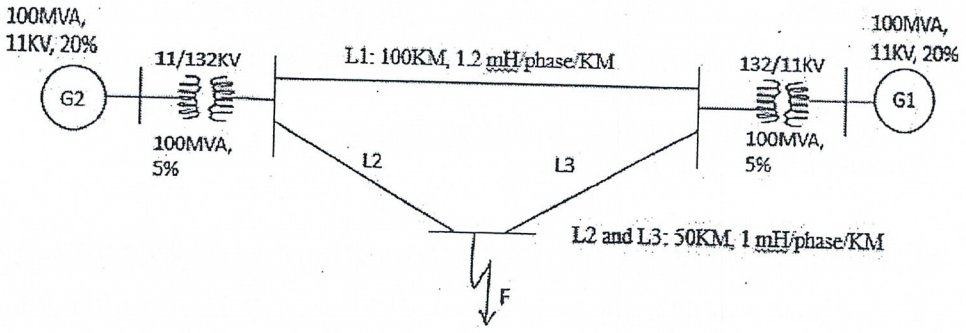


Table: Bus data

Bus	Bus type	Injected P	Injected Q	Bus voltage magnitude	Voltage phase angle
1	Slack	-	-	1	0
2	PV	0.6	-	1	-
3	PQ	-0.5	-0.4	-	-

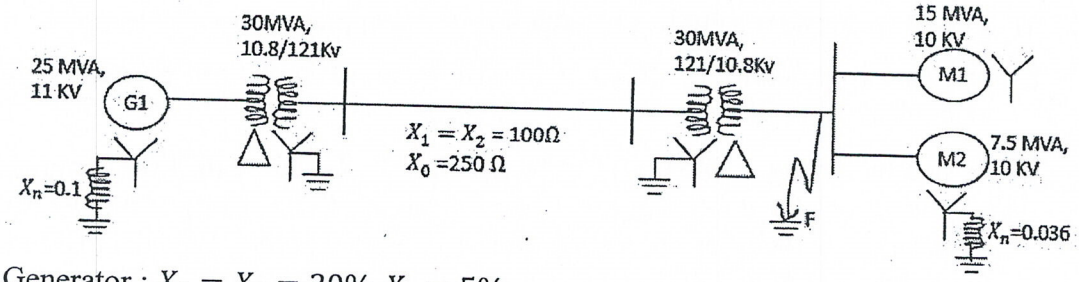
3. a) With suitable mathematical aid, show that in a delta connection, zero sequence components of current are absent in the line currents. [5]

b) The figure below shows a power system network. A three-phase fault occurs at point F in the system. Using the given system data: Determine the fault MVA at the point of fault and the corresponding fault current. [4+3]



4. a) Show that for the two-conductor open circuit fault in a 3-phase system, the sequence networks are to be connected in series to simulate the fault. [5]

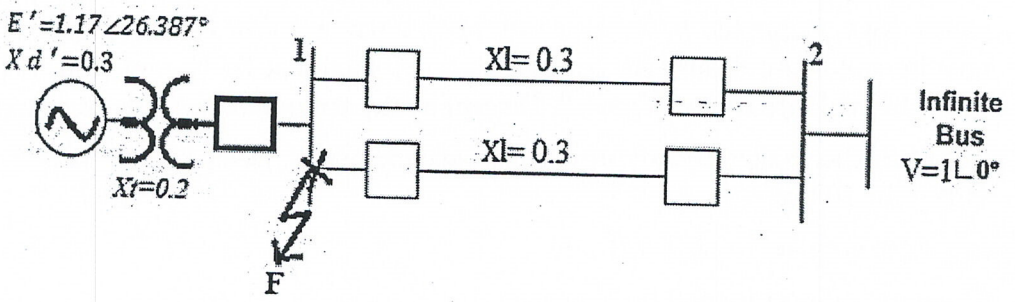
b) For the power system network shown below, if Line to Line fault occurs at point 'F' then find the fault current, take fault impedance $Z_f = 0.1\,p.u.$ [7]



For Generator : $X_1 = X_2 = 20\%, X_0 = 5\%$
For Both Motor : $X_1 = X_2 = 25\%, X_0 = 10\%$
For Both Transformer : $X_1 = X_2 = X_0 = 10\%$
The neutral reactance of generator G_1 and motor M_2 are in p.u.

5. a) Justify with appropriate expression that synchronizing power coefficient must be positive for a stable equilibrium power system operating condition. [5]

b) A 60 Hz synchronous generator has inertia constant $H = 5\ MJ/MVA$ and a direct axis transient reactance $X_d' = 0.3\,p.u.$ connected to an infinite bus $V = 1 < 0°$. The generator has internal emf $E' = 1.17 < 26.387°\,p.u.$ and $P_e = 0.8\,p.u.$ The reactance of transformer and both transmission line are in p.u. A temporary 3-phase fault occurs at the sending end of the line at point 'F'. When the fault is cleared, both the lines is intact. Determine the critical clearing angle and the critical clearing time. [4+3]



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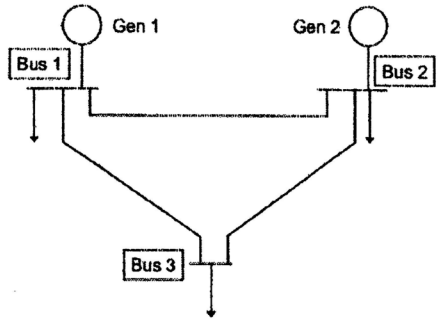
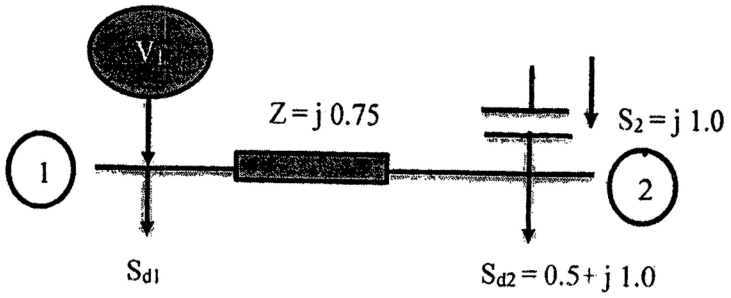
1. a) Explain the consequences of real power on frequency and reactive power on voltage problems in a power system. Also, illustrate the basic control mechanisms in brief to address these are in the real power system. [3+2]

   b) Consider a 3-bus power system network. The series impedance and shunt admittance of each line are 0.026 + j 0.11 pu and j 0.04 pu respectively. Find: [3+4]
   (i) the bus admittance matrix.
   (ii) the modified bus admittance matrix if a tap changing transformer inserted in mid-point between bus 2 and 3 having turn ration $t = e^{j30°}$



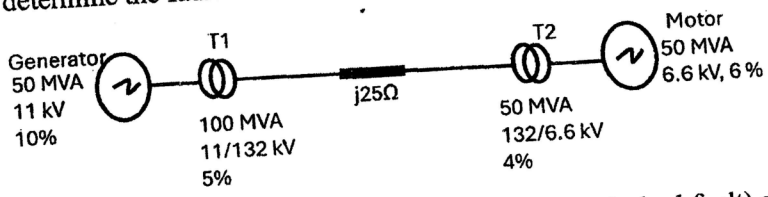
2. a) Why load flow analysis is need in power system? Point out the significance of the slack bus. [2+3]

   b) Using G-S load flow analysis, compute the voltage at bus 2 of figure shown below if $V_1 = 1\angle 0^\circ$ pu. Find also power flow between bus 1 and 2. (all values are in pu). [4+3]



3. a) Explain the significance of symmetrical components in power system analysis. Also derive the expression for phasor voltages in terms of the symmetrical components of voltages. [2+3]

b) An alternator is connected to a synchronous motor through a transmission line and two transformers as shown in the figure below. The rated MVA, voltage rating and percentage reactance of the components are depicted in the figure. The transmission line reactance is also shown in the figure in Ω. Compute the fault current, if a 3-phase bolted fault occurs at the terminal of the generator. Consider the pre fault voltage as 1 p.u. Also determine the fault MVA at the generator terminal. [3+4]



4. a) Obtain the sequence network for double line to ground fault (bolted fault) at alternator terminal. [5]

b) A 50 MVA, 12 kV, three-phase alternator were subjected to different types of faults. The fault currents were: [7]

(i) 1870 A for three-phase fault
(ii) 2590 A for L-L fault
(iii) 4130 A for L-G fault.

The alternator neutral is solidly grounded. Find the three-sequence reactance of the alternator in per unit.

5. a) Define steady state and transient stability of power system. Point out the methods of improving transient stability of a power system. [3+2]

b) Starting from the single machine swing equation, derive the expression for equivalent swing equation for multiple generators swinging together. Three generators in a power plant of 50 MVA, 100 MVA & 200 MVA have inertia constant of 6 MJ/MVA each. Compute the equivalent inertia constant at a base of 100 MVA if all units swing together. [4+3]

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