INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEE/I)

EEE 2106: ELECTRICAL POWER SYSTEM
FINAL EXAMINATION: JAN2012 SESSION

Instructions: This paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions in the answer booklet provided. All questions carry equal marks.

Question 1

(a) A 3-phase, 50 Hz, 440 V motor develops 80 hp with the power factor being 0.8 lagging and 90% efficiency. A bank of capacitor is connected in delta across the supply terminals and resulted to a power factor 0.95 lagging. Each of the capacitance units is built with 4 similar capacitors connected in series. Determine the capacitance of each capacitor.

(10 marks)

(b) A single phase ring distribution ABC is fed at A with voltage at bus A adjusted to 1.05 pu. The loads at B and C are 279.2626 MVA at 0.9188 p.f. lagging and 145.7841 MVA at 0.9507 p.f. lagging, respectively. Both power factors expressed are referred to the voltage at point A. The total impedance of sections AB, BC, and CA are (0.02 + j0.04), (0.0125 + j0.025) and (0.01+ j0.03) Ω respectively. Determine the line currents in the sections of the ring distributor.

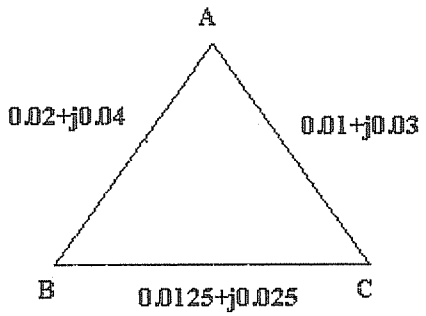

Figure 1(b): Single phase distribution ring

Note: Assume initial bus voltage at B and C to be 1 pu.

(15 marks)

Question 2

(a) A power generating station has an overall efficiency of 15% and 0.76 kg of coal is burnt per kWh. Determine the calorific value of the coal used [kCal/kg]. Assume one calorie is equal to 4.178 joules. (5 marks)

(b) (i) The following figure shows a distribution network from a main sub-station. There are four feeders connected to each center sub-station. The connected loads on various feeders and their maximum demand are as follow:

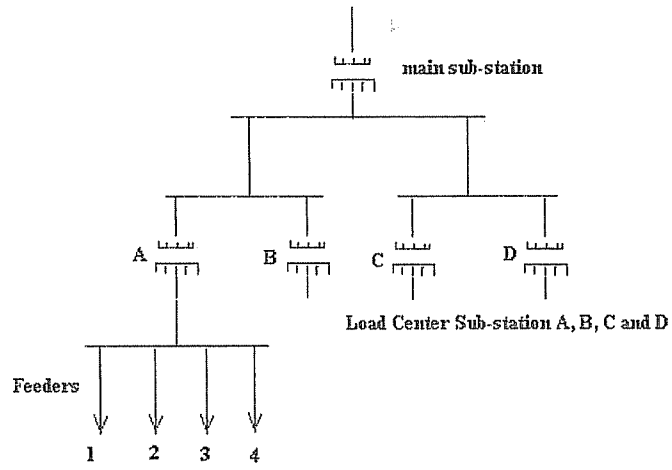

Figure 2(b)(i): Distribution network

(5 marks)

Feeder No.	Connected Load	Maximum Demand
1	125 kW	100 kW
2	125 kW	100 kW
3	500 kW	300 kW
4	600 kW	500 kW

Taking the actual demand on each load centers as 800 kW, calculate the diversity factor on the feeders.

(5 marks)

(ii) Assuming load centers B, C and D are similar to A and taking the diversity factor between the load centers as 1.1, calculate the maximum demand of the main sub-station. What capacity of transformer will be required at the main station? (5 marks)

(iii) The future electric power demand will increase steadily at a fix rate. The maximum demand on feeder 1, 2, 3 and 4 ten years later will be 200 kW, 200 kW, 600 kW and 1000 kW respectively. Calculate the percentage rate of growth of demand for each feeder. (5 marks)

(iv) If the rate of growth should continue for all other feeders on the rest of the load centers, what will be the maximum demand of the main station in 15 years? (5 marks)

Question 3

(a) A 50 Hz, 3-phase transmission line has the following constants:
R = 10 Ω/phase; inductive reactance = 20 Ω/phase; capacitive susceptance = 4×10^{-4} mho/phase.
Calculate the following when the line is supplying a balanced load of 10,000 kW at 66 kV, 0.8 p.f. lagging, using nominal T method:

(i) Sending end voltage (3 marks)
(ii) Line current (3 marks)
(iii) Sending end power factor and transmission efficiency (3 marks)

(b) A single core cable of 0.5 km long has a core diameter of 0.5 cm and diameter under sheath of 2 cm. The relative permittivity of insulating material is 3.2. The supply voltage is 11 kV, 50 Hz. Take specific resistance of insulation as 5×10^{12} Ω/m, calculate the following:

(i) The capacitance of the cable (4 marks)
(ii) The insulation resistance (4 marks)
(iii) The charging current per conductor (4 marks)
(iv) The dielectric loss (4 marks)

Question 4

(a) A single-phase transmission line supplies a reactive load at lagging power factor. The load draws 1.2 p.u. current at 0.6 p.u. voltage while drawing 0.5 p.u. (active) power. If the base voltage is 20 kV and the base current is 160 A, calculate the power factor and ohmic value of the resistance of the load.

(10 marks)

(b) A 3-phase load of 10 MW at 0.8 p.f. lagging is supplied at 33 kV by an overhead line, each conductor of which has a resistance of 2.9 Ω and an inductive reactance of 6.5 Ω. A three-phase bank of capacitors is connected to the load end of the line so that the voltage at the sending end is equal to that at the load. Calculate the KVAR rating of the capacitors.

(15 marks)

Question 5

(a) The variable operating cost of two generating units are given by
$F_1 = 12P_1 + 0.015P_1^2$ RM/hr
$F_2 = 10P_2 + 0.018P_2^2$ RM/hr
If the total load demand varies from 125, 130 and 140 MW, determine the
(i) power output of each unit,
(ii) incremental operation cost,
(iii)total operating cost, F_T, that minimize F_T for the following load demands.

(12 marks)

(b) The two generating units are supplying to the grid as indicated in the following figure, Figure Q5. The per unit voltage, current and impedance value are given as follow.

$I_1 = 1\angle 0°$
$I_2 = 0.8\angle 0°$
$V_1 = 1.05\angle 10°$
$V_2 = 1.07\angle 15°$
$Z_1 = 0.05 + j0.2$
$Z_2 = 0.06 + j0.3$
$Z_3 = 0.06 + j0.4$

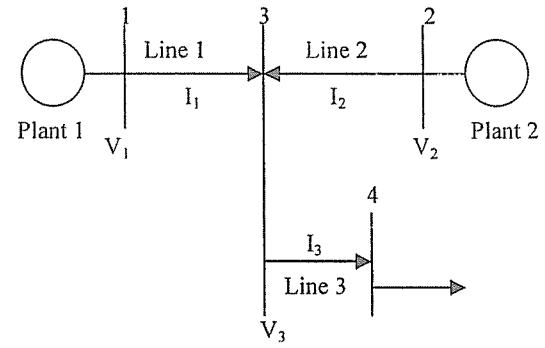

Figure Q5

(i) Find out the system line coefficients, and (6 marks)

(ii) Determine the penalty factor associated with each generating units. (7 marks)

Question 6

(a) A simple three-bus power system single line diagram is shown in the following Figure Q6. All impedances are expressed in per unit on a common 50 MVA base, with the resistances conveniently neglected. All generators are running at their rated voltage, or 1p.u., and rated frequency with their e.m.f.s in phase.

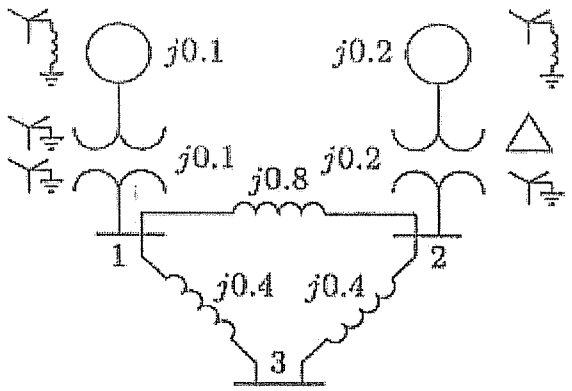

Figure Q6

If a balanced three-phase fault with a fault impedance $Z_f = 0.16$ p.u. occur on Bus 3, find the following in p.u.:

(i) Equivalent impedance of the power system in fault condition (6 marks)

(ii) The fault current flowing through Bus 3, assuming all prefault bus voltages are equal to 1.0 p.u. (4 marks)

(iii) The bus voltages on all three bus after fault (8 marks)

(iv) The short-circuit current in all the lines connecting the buses (7 marks)

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