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INTERNATIONAL COLLEGE PENANG (507232-U)
LAUREATE INTERNATIONAL UNIVERSITIES

FINAL
Examination Paper

(COVER PAGE)

Session : APRIL 2013

Programme : DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING

Course : **EEE 2106 ELECTRICAL POWER SYSTEM**

Date of Examination : 29/7/2013

Time : 11 a.m. to 1 p.m. Reading Time : Nil

Duration : 2 Hours

Special Instructions :

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

Materials permitted :

Non-Programmable Scientific Calculator

Materials provided :

Nil

Examiner(s) : **KEN KONG SENG KUOK**

Moderator : **DR. OOI BENG LEE**

*This paper consists of 5 printed pages, including the cover page.*

INTI INTERNATIONAL COLLEGE PENANG

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

EEE 2106: ELECTRICAL POWER SYSTEM
FINAL EXAMINATION: APR2013 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) Consider a new shopping complex capable of housing 500 tenants. Assume that 25% of the tenants are seasonal, operating actively from October to March and closing shop 50% for the remaining time in the year. The remaining tenants will be operating steadily throughout the year. Each tenant on the average will install 4 power points, drawing 0.2 A of current each, and 9 lighting points consuming at most 405 W.
The regular business hour is from 11 a.m. to 11 p.m. The central cooling system is operating at 1 MW during the business hour and shut down for the rest of the day. General lighting in the building is consuming 12.5 kW during the business hour.
Busiest shopping seasons are January, February, August and December. During these periods of the year, the general power consumption of the building will increase by 20%.

(i) Plot the yearly load curve according to the information provided. (Use average value for each month) (11 marks)

(ii) Find the maximum demand and load factor from the load curve constructed in part (i). (3 marks)

(iii) The distribution substation nearby is supplying 1.6 MVA during busiest months during business hour. Calculate the reactive power consumption in the shopping complex. (3 marks)

(b) Consider the following diagram.

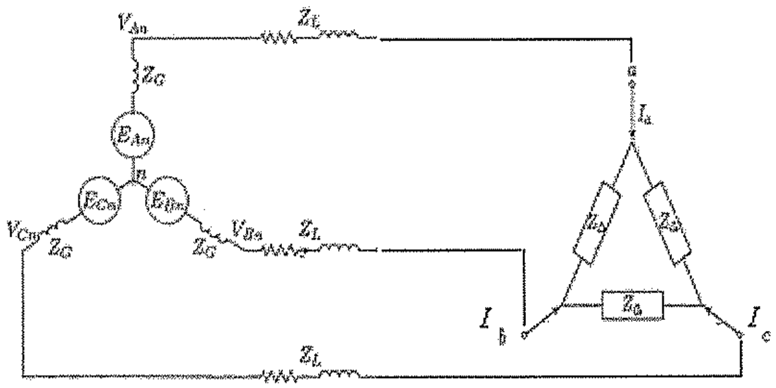


Figure 1(b): Three phase connection

Given the phase-to-neutral voltage supply is 230 V. The generator impedance is 0.012 Ω. The line impedance is 0.01 + 0.25j Ω. The load impedance, $Z_\Delta$, is 100 + 20j Ω.

(i) Draw a per phase diagram for the figure. (3 marks)

(ii) Find the value of the current, $\mathbf{I_a}$, $\mathbf{I_b}$ and $\mathbf{I_c}$, feeding into the delta ring. (5 marks)

**Question 2**

(a) Describe the three factors that affect the windmill's energy output. (9 marks)

(b) During non monsoon season, the average wind speed in east coast of Malaysia is 30 km/h. During the monsoon season, the average wind speed would surpass 100 km/h. The cheapest available wind generator in these regions is of the type that can produce 10 kW at rated speed of 400 r.p.m. and has a tip speed ratio (T.S.R.) of 5. The blades are 3 m in length. If the energy supplying body is to use these wind generators to satisfy the demand of 10,000 household along the coastal region with the average demand of 2 kW per household, how many wind generators are sufficient to provide for an all year round demand of these households? Assume 80% load factor. The air density is 1.201 kg/m$^3$. Assuming the output capacity of the generators is in direct proportion to the wind speed and the cut-in wind speed is 5 m/s. (10 marks)

(c) Furling is general description of methods in protecting wind turbine in strong wind. Describe two furling methods commonly in use with modern wind turbine. (6 marks)

**Question 3**

(a) A 50 Hz, 3-phase transmission line of 100 km delivers 20 MW at 0.9 p.f. lagging and at 110 kV. The resistance and reactance of the line per phase are 0.2 Ω/km and 0.4 Ω/km respectively, while capacitive admittance is 2.5 μS/km.
Calculate using nominal T method:
  (i) Sending end voltage and current (11 marks)
  (ii) Efficiency of transmission (4 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 $5\times10^{12}$ Ω/m, calculate the following:
  (i) The capacitance of the cable, with $\varepsilon_o = 8.845 \times 10^{-12}$ Fm$^{-1}$ (3 marks)
  (ii) The insulation resistance (3 marks)
  (iii) The charging current per conductor (2 marks)
  (iv) The dielectric loss (2 marks)

**Question 4**

(a) Describe two voltage control methods involving static capacitors and transformers respectively.

(10 marks)

(b) A transmission line rated with 132 kV is fed at the sending end with a 22/132kV transformer fetching a constant 22 kV supply. At the receiving end, the voltage is step-down with a transformer with nominal ratio 132/22kV. The total impedance of the transmission line inclusive of transformers is 25+j66 Ω. Both transformers are equipped with tap-changing capabilities with the product of the two off-nominal settings being unity. If the load of the system is 100 MW at 0.9 p.f. lagging, calculate the settings of the tap-changing transformers that could maintain the voltage at the load bus bar at 22 kV.

Note: Use a base of 100 MVA.

(15 marks)

**Question 5**

(a) The variable operating cost of three generating units are given by

$F_1 = 350 + 7.20P_1 + 0.0040P_1^2$ RM/hr

$F_2 = 500 + 7.30P_2 + 0.0025P_2^2$ RM/hr

$F_3 = 600 + 6.74P_3 + 0.0030P_3^2$ RM/hr

where $P_1$, $P_2$ and $P_3$ are in MW. The governors are set such that generators share the load equally. Neglecting line losses and generator limits, find the total cost in RM/hr for the following cases

(i) Case 1: Total demand, $P_D = 450$ MW (2 marks)

(ii) Case 2: Total demand, $P_D = 745$ MW (2 marks)

(iii) Case 3: Total demand, $P_D = 1335$ MW (2 marks)

(b) The generating units in question (a) have generating limits (in MW) as follow:

$90 \leq P_1 \leq 150$

$120 \leq P_2 \leq 450$

$200 \leq P_3 \leq 750$

(i) Neglecting line losses, determine the optimal scheduling of generation for each loading as in question (a) using analytical method. (16 marks)

(ii) Find the savings in RM/hr for each case compared to the costs in question (a). (3 marks)

**Question 6**

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.

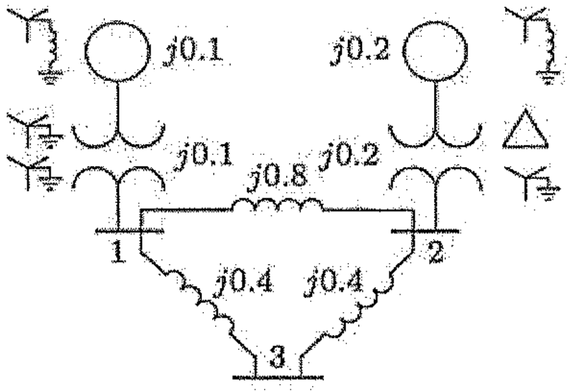


Figure Q6

If a balanced three-phase fault with a fault impedance $Z_f = 0.16$ p.u. occur on Bus 2, find the following in p.u.:

(a) Equivalent impedance of the power system in fault condition (8 marks)

(b) The fault current flowing through Bus 2, assuming all prefault bus voltages are equal to 1.0 p.u. (2 marks)

(c) The bus voltages on all three bus after fault (9 marks)

(d) The short-circuit current in all the lines connecting the buses (6 marks)

**--THE END—**

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