INTI
INTERNATIONAL COLLEGE PENANG (507232-U)
LAUREATE INTERNATIONAL UNIVERSITIES

FINAL
Examination Paper

(COVER PAGE)

Session : August 2016

Programme : DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING

Course : **EEE 2106 ELECTRICAL POWER SYSTEMS**

Date of Examination : 7 December 2016 (Wednesday)

Time : 11:00am – 1:00pm 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 : **CHEAH KEAN SENG**

This paper consists of 6 printed pages, including the cover page.

INTI INTERNATIONAL COLLEGE PENANG

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING PROGRAMME (DEEI)
EEE2106: ELECTRIC POWER SYSTEMS
FINAL EXAMINATIONS: AUGUST 2016 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) The transmission line can be represented with suitable 2-port network model. Describe the conditions in terms of length and voltage magnitude for using the following?

(i) short line model (2 marks)
(ii) medium line model (2 marks)
(iii) long line model (2 marks)

(b) A 50-Hz 3-phase transmission line has the following constants:

$R = 5\ \Omega$ / phase
Inductive reactance = $20\ \Omega$ / phase
Capacitive susceptance = 4×10^{-4} mho / phase

When the line terminated in a balanced load of 1,000 kW at 33-kV, 0.8 p.f. lagging, calculate the following:

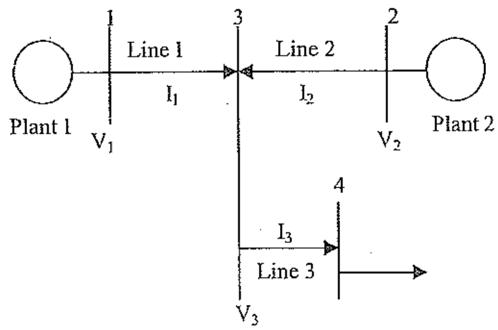
(i) Sending end voltage (9 marks)
(ii) Line current (5 marks)
(iii) Power factor at the sending end (2 marks)
(iv) Efficiency of transmission (3 marks)

Question 2

(a) The two generating units are supplying to the grid as indicated in the following figure, Figure Q2(a). 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 Q2(a)



Find out the system line coefficients. (12 marks)

(b) Determine the penalty factor associated with each plant in Figure Q2(a). (13 marks)

Question 3

(a) A power station has the daily load curve given by the following:

Time (hrs)	12 pm – 7 am	7 – 9 am	9 – 11 am	11 am – 4 pm	4 – 10 pm	10 – 12 pm
Load (MW)	2	10	4.5	7	4	2.5

Plot the following curves:

(i) Daily load curve (5 marks)

(ii) Load duration curve (5 marks)

(iii) Load energy curve (5 marks)

(b) From the information in part (a), determine the total energy produced per annum and annual load factor if the capacity of the station is 18 MW. (10 marks)

Question 4

(a) A 66 kV line is fed through an 11/66 kV step-up transformer from an 11 kV supply. At the load end of the line the voltage is step-down by another transformer of nominal ratio 66/11 kV. The total impedance of the line and transformers at 66 kV is 12.5 + j33 Ω. Both transformers are equipped with tap-changing facilities which are arranged so that the product of the two off-nominal settings is unity. If the load on the system is 50 MW at 0.8 pf lagging, calculate the settings of the tap changer required to maintain the voltage of the load busbar at 11 kV. Use the base power of 50 MVA.

(13 marks)

(b) A single core cable has a conductor radius r, internal radius of sheath R and V is the potential of the conductor relative to sheath. Prove that the potential gradient g_{max} will have a minimum value when $\frac{R}{r} = e$.

(6 marks)

(c) Calculate the economic size of a single core cable in which g_{max} = 40,000 V/cm and operating voltage is 50 kV.

(6 marks)

Question 5

The variable operating cost of three generating units are given by

$F_1 = 655 + 6.8P_1 + 0.007P_1^2$ RM/hr

$F_2 = 695 + 6.5P_2 + 0.006P_2^2$ RM/hr

$F_3 = 755 + 6.0P_3 + 0.005P_3^2$ RM/hr

If the total load demand varies from 150, 220 and 340 MW, determine the

(i) incremental operation cost at each demand level, (8 marks)

(ii) power output of each unit at the mentioned demand level, (10 marks)

(iii) total operating cost, F_T, that minimize F_T for the above-mentioned load demands. (7 marks)

Question 6

(a) Explain the following tariff:

(i) Simple tariff (5 marks)

(ii) Sliding scale tariff (5 marks)

(iii) Two-part tariff (5 marks)

(b) An electric supply company supplies a maximum peak load of 250 kW and load factor is 40%. Find the total cost of energy consumption per annum based on the following two tariffs offered:

(i) RM 150 per kW of maximum demand plus 35 sen per kWh (5 marks)

(ii) A flat rate of 40 sen per kWh (5 marks)

~The End~

Summary of Equations:

Load Study

$$average\ demand(W) = \frac{total\ energy\ demand\ (W \cdot hr)}{total\ time\ (hr)}$$

$$load\ factor = \frac{average\ demand(W)}{maximum\ demand(W)}$$

$$demand\ factor = \frac{maximum\ demand(W)}{total\ connected\ load(W)}$$

$$diversity\ factor = \frac{sum\ of\ individual\ maximum\ demand(W)}{maximum\ demand\ on\ power\ station\ (W)}$$

$$plant\ capacity\ factor(plant\ factor) = \frac{average\ demand\ on\ the\ plant(W)}{total\ plant\ capacity(W)}$$

$$plant\ use\ factor(utilization\ factor) = \frac{actual\ energy\ produced(W \cdot hr)}{plant\ capacity(W) \times total\ time(hr)}$$

Per Unit System

$$Z_{pu(new)} = Z_{pu(old)} \times \left(\frac{V_{b(old)}}{V_{b(new)}}\right)^2 \times \frac{VA_{base(new)}}{VA_{base(old)}}$$

(changing per unit value from one base reference to another base reference)

Transmission Line Model

π model:

$$\begin{bmatrix} V_S \\ I_S \end{bmatrix} = \begin{bmatrix} 1 + \frac{YZ}{2} & Z \\ Y + \frac{Y^2 Z}{4} & 1 + \frac{YZ}{2} \end{bmatrix} \begin{bmatrix} V_R \\ I_R \end{bmatrix}$$

T model:

$$\begin{bmatrix} V_S \\ I_S \end{bmatrix} = \begin{bmatrix} 1 + \frac{YZ}{2} & Z + \frac{Z^2 Y}{4} \\ Y & 1 + \frac{YZ}{2} \end{bmatrix} \begin{bmatrix} V_R \\ I_R \end{bmatrix}$$

Cable Grading

$$g = \frac{V12}{x\ln\left(\frac{D2}{D1}\right)}$$ (dielectric stress)

$$V_n = g_{max}\, r_{n-1} \ln\left(\frac{r_n}{r_{n-1}}\right) ;\ n = 1, 2, 3\ldots$$ (voltage distribution)

Optimal Dispatch

$$\lambda = \frac{P_D + \sum_{i=1}^{n} \frac{\beta_i}{2\gamma_i}}{\sum_{i=1}^{n} \frac{1}{2\gamma_i}}$$ (incremental cost)

$$P_i = \frac{\lambda - \beta_i}{2\gamma_i}$$ (power output)

Line Coefficients

$P_L = P_1^2 B_{11} + 2P_1P_2B_{12} + P_2^2 B_{22}$ (power loss expression for two plant system)

$B_{11} = (R_a + R_c)/(V_1\cos\theta_1)^2$

$B_{22} = (R_b + R_c) / (V_2\cos\theta_2)^2$

$B_{12} = R_c/(V_1\cos\theta_1 V_2\cos\theta_2)$

<u>Penalty Factor</u>

$L_i = (1 - \partial P_L / \partial P_i)^{-1}$

<u>Voltage Control Method</u>

$$t_s = \sqrt{\frac{\frac{|V_1|}{|V_2|}}{1 - \frac{R\ P\ + X\ Q}{|V_1||V_2|}}}$$

(tap-changing transformer adjustment ratio)