UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET

COURSE CODE	: BET 3053
COURSE	: POWER SYSTEM AND CONTROL
SEM/SESSION	: 1 - 2024/2025
DURATION	: 3 HOURS

Instructions:

1. This booklet contains **4** questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 4 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) Define power system SCADA. (2 marks)

b) Compare between SCADA and DCS (8 marks)

QUESTION 2

a) Consider one generation facility consists of two generators PG1 and PG2. Cost curves for each is listed as follows:

$$C1\ (PG1) = 580 + 16PG1 + 0.04PG1^2\ RM/h$$
$$C2\ (PG2) = 360 + 10PG2 + 0.06PG2^2\ RM/h$$

The total generated power from PG1 and PG2 is 800MW. By using Langrange multiplier method:

i. Find the incremental cost (λ) in RM/h. (2 marks)

ii. For optimal dispatch to meet PD = 800MW, match cost must similar ($\lambda 1 = \lambda 2$). (1 marks)

iii. Classify the output of each generator at optimal dispatch PG1, PG2. (2 marks)

iv. Find the total cost of operation, C_T. (2 marks)

QUESTION 3

a) Two generators are set to supply the same load. Generator 1 has a no load frequency of 64.5 Hz and a slope S_{P1} of 2 MW/Hz. Generator 2 has a no-load frequency of 64.0 Hz and a slope S_{P2} of 2 MW/Hz. The two generators are supplying a real load of 3.5 MW at 0.75 power factor lagging.

i. Find the system frequency and power generated by G1 and G2. (3 marks)

ii. Assuming that an additional 1.5 MW load is attached to the power system. Match the new system frequency and power supplied by each generator. (5 marks)

iii. With the total additional load attached is 2.5 MW, calculate the system frequency and the generator powers, if the no-load frequency of G_2 is increased by 0.5 Hz. (5 marks)

QUESTION 4

a) A 415 V 50 Hz installation at Factory X supplies the loads as in table 1:

Table 1

Load	Description
A	Lighting 40 kW at unity power factor
B	An induction motor of full load efficiency 88%, Power output 20 HP (take 1 HP = 746 W)
C	Other consumable loads 45kVA at 0.75 power factor lagging
D	Capacitance loads 4 kVar leading

If the overall system power factor is 0.8 lagging,

i. Find the power factor of the induction motor in per unit. (7 marks)

ii. Calculate the line current. (3 marks)

.....END OF QUESTION.....

LIST OF FORMULA

$$(C_i) = \sum_{i=1}^{NG} (\alpha_i + \beta_i P_i + \gamma_i P_i^2)$$

$$P_{G1} + P_{G2} = P_D$$

$$P_i = \frac{\lambda - \beta_i}{2\gamma_i}$$

$$Ft = F1 + F2$$

$$\Delta P = P_o - \sum_{i=1}^{3} P_i$$

$$\lambda^{k+1} = \frac{\Delta P^k}{\sum \frac{1}{2\gamma_i}}$$

$$\lambda,\ \lambda^{k+1} = \lambda^k + \Delta\lambda^{(k)}$$

$$ns = \frac{120f}{p}$$

$$f_{sys} = f_{nl} - \frac{P}{S_P}$$

$$P_{load} = P_1 + P_2 = S_{P1}(f_{nl,1} - f_{sys}) + S_{P2}(f_{nl,2} - f_{sys})$$

$$\cos\theta = \frac{P}{S}$$

$$\sin\theta = \frac{Q}{S}$$

$$\tan\theta = \frac{Q}{P}$$

$$\eta = \frac{P_{out}}{P_{in}}$$

$$I_L = \frac{P_{in}}{\sqrt{3} V_{LL}}$$

$$X_C = \frac{V^2}{Q}$$

$$C = \frac{1}{2\pi f X_C}$$

$$V_{dc} = \frac{3\sqrt{2}}{\pi} V_{LL} \cos\alpha$$

$$I_{dc} = \frac{V_{dc}}{r}$$

$$P_o = i_{o(rms)}^2 r$$

$$PF_{in} = \sqrt{\frac{2\pi + 3\sqrt{3}\cos(2\alpha)}{4\pi}}$$