MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING TECHNOLOGY

DEPARTMENT OF ELECTRICAL ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

FIFTH YEAR **SECOND** SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EES 517: POWER SYSTEMS ECONOMIC AND PLANNING

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer Question one and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a) Classify power system stability into its THREE broad categories and provide explanations for each. (4.5marks)

b) With the reference to electricity _____ explain the following terms.

   i. Monopoly (1.5 marks)

   ii. Bilateral trading (1.5marks)

   iii. Forward contracts (1.5marks)

c) A synchronous generator having equivalent reactance 1.2 pu is connected to an infinite bus bar IVI=1.0pu through transformers and a line of total reactance 0.60pu. The system frequency is 50____. The generator no-load voltage is 1.20pu and its inertia constant H=4mws/mvA. The resistance and ma_____damping may be assumed negligible. Calculate the natural frequency of oscillations if the generator is loaded to

   i. 50% of its maximum power limit (3.5marks)

   ii. 90% of its maximum power limit (3.5marks)

d) State THREE importance of daily load curves in a power station. (3marks)

TWO (20 MARKS)

e) i. Discuss FOUR important points to be taken into consideration while selecting the size and number of generating units in a power plant (4marks)

   iii. A transformer in a power station costs Kshs.1,560,000 and has a salvage value of Kshs.60,000 at the end of 25years. Determine the depreciated value of the transformer at the end of 20 years using straight line method (3marks)

f) Explain the relationship between the heat-rate curve and the fuel cost _____ of a thermos power plant giving expression for the fuel cost function for the thermal plant. (4marks)

SECTION TWO: ANSWER ANY TWO QUESTIONS

QUESTION TWO (20 MARKS)

a) Create and explain a model that visually represents the purchasing agency model of competition in electricity market. (9marks)

b) The fuel cost functions for three thermal plants in $/h are given by

$$c_1 = 500 + 4_1 p_1 + 0.15 p_1^2$$

$$c_2 = 400 + 44 p_2 + 0.1 p_2^2$$

$$c_3 = 300 + 40 p_3 + 0.18 p_3^2$$

Where P1P2 and P3 are in mw the total load is 850 mw. Neglecting line losses and generator limits, find the optimal dispatch and total fuel cost by_____ tech_____assume the initial value of _____ (11marks)

QUESTION THREE (20 MARKS)

a) Explain THREE methods of improving transient stability in power systems (6marks)

b) The power system netwons shown in figure comprises of a one-line diagram of a generator supplying power to an infinite bus over two parallel transmission lines. The reactance of the generator, each transformer and each transmission line are 0.3, 0.2 and 0.25 respectively, per unit. Unit, power is delivered to the infinite bus at unity power factor. The infinites bus voltage is 1.0pu. A three-phase fault occurs at the receiving end of one of the transmission lines and is cleared by the simultaneous opening of the circuit breaker 5 and 7. Using the equal area method, find the critical clearing angle of the generator such that the system remains stable. Sketch the power angle diagram (14marks)

QUESTION FOUR (20 MARKS)

a) Form the bus admittance matrix for the power system network shown in figure 2 (2marks)

b) Compare Gauss Seided and Newton Raphson as methods for solving load flow studies (6marks)

c) In the two-bus system shown in figure 3, use Newtorn – Raphson power flow method to obtain the voltage unagritude and phase angle of bus 2. Bus 1b slack bus with v_1=1.0< $0^o pu$. The line admittance in as shown and expressed in per unit on a common base of

100mvA. Start with an initial estimate of $\left|v_2^{(0)}\right|$= 1.0pu and $f_2^{(0)} = 0^0$, perform one itevation. (12marks)