MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 538: POWER SYSTEM DYNAMICS AND CONTROL

DATE: 22/5/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS

Answer Question ONE and any other TWO Questions.

QUESTION ONE (30 MARKS)

a) The heat rate of a 100MW fuel fired generator unit is measured as follows:

25% of rating : 10Mkcal/MWhr

50% of rating : 8.6Mkcal/MWhr

100% of rating : 8Mkcal/MWhr.

Cost of fuel is kshs. 500 per Mkcal. Determine:

(i) Fuel cost function

(ii) The fuel cost when100% loaded, 50%loaded and 25% loaded

(iii) The incremental cost

(iv) The exact cost of fuel to deliver 105MW. (12 marks)

b) State any four objectives of reactive power management in power system units. (4 marks)

c) The fuel cost for a plant consisting of two units are:

$C_1 = 0.1{P_1}^2 + 40P_1 + 120$Sh/hr

$C_2 = 0.2{P_2}^2 + 40P_2 + 100$Sh/hr

The generator limits are:

$30 \leq P_1 \leq 175$ MW

$20 \leq P_2 \leq 125$ MW

i. Assuming that both units operate all the times, determine the load sharing between the units for the system load of 55, 200 and 290MW. Give the value of the incremental cost in each case.

ii. If the plant has a daily load cycle of 290MW from 6am to 6pm and 55MW for the rest of the time, determine whether it would be more economical to keep both units in service for 24 hours or to remove one of the units from service during light load. The cost incurred in taking either unit off the line and returning it after 12 hour is sh. 400. (14 marks)

QUESTION TWO (20 MARKS)

Three thermal units deliver a total load of 850MW. Their cost functions and generator limits are as follows:

$C_1 = 780 + 79.7P_1 + 0.0482\ P_1^{\ 2}$ shs/hr

$50 \leq\ P_1 \leq 200$MW

$C_2 = 3100 + 78.5P_2 + 0.0194\ P_2^{\ 2}$ shs/hr

$100 \leq P_2 \leq 400$MW

$C_3 = 4590 + 64.8P_3 + 0.0128\ P_3^{\ 2}$ shs/hr

$150 \leq\ P_3 \leq 600$MW

Where P_1, P_2 and P_3 are the outputs of the units 1, 2 and 3 respectively in MW. Determine the economic operation point for the three units and their corresponding incremental cost.

(20 marks)

QUESTION THREE (20 MARKS)

a) State any four advantages of interconnected power systems. (4 marks)

b) With an aid of a schematic diagram, describe the operation of a voltage regulator and turbine governor in control of steam turbine generator. (8 marks)

c) With the aid of a circuit diagram, describe the operation of ON – load tap changing transformer as a method of voltage control. (8 marks)

QUESTION FOUR (20 MARKS)

a) An area of interconnected power system has two fossil-fuel units operating on economic dispatch. The variable operating cost of these units are given by:

$C_1 = 10P_1 + 8\times 10^{-3}\ {P_1}^2$ shs/hr

$C_2 = 8P_2 + 9\times 10^{-3}\ {P_2}^2$ shs/hr

$where\ P_1$ and P_2 are MW.

If the load varies from 500MW to 1500MW

Determine:

(i) The output of each unit

(ii) The incremental operating cost

(iii) The total operating cost as the load varies from 500MW to 1500MW. (12 marks)

b) State any four roles of AGC in frequency control (4 marks)

c) Differentiate between a constant speed governor and speed droop governor (4 marks)

QUESTION FIVE (20 MARKS)

a) Three generating units operating in parallel at 60HZ have ratings of 300MW, 500MW and 600MW and have speed droop of 5%, 4% and 3% respectively. Due to a change in load an increase in system frequency of 0.3HZ is experienced before any supplementary control action occurs. Determine:

i. The change in system load

ii. The change in generation of each unit to absorb the load change. (10 marks)

b) Three generating stations supply powers of P_1 = 100MW, P_2 = 200MW and P_3 = 400MW respectively into power networks. Determine the transmission loss in the network and the value of $\frac{\delta PL}{\delta pi}$, given that B_{11} = 0.011, B_{22} = 0.03, B_{33} = 0.04, B_{12} = 0.001, B_{23} = 0.0004, and B_{31} = -0.001 (10 marks)