MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 552: POWER SYSTEMS DYNAMICS AND CONTROL

DATE: 15/12/2017 **TIME: 8.30-10.30 AM**

INSTRUCTIONS:

Answer Question One and any other two questions

QUESTION ONE (30 MARKS)

a) Fig.1 shows load curve of a given city. The city is supplied by two units whose cost curves are:
$F_1 = 0.1P_1^2 + 40P_1 + 130\ KSH/hr;\ \ F_2 = 0.125P_2^2 + 30P_2 + 80KSH/hr.$

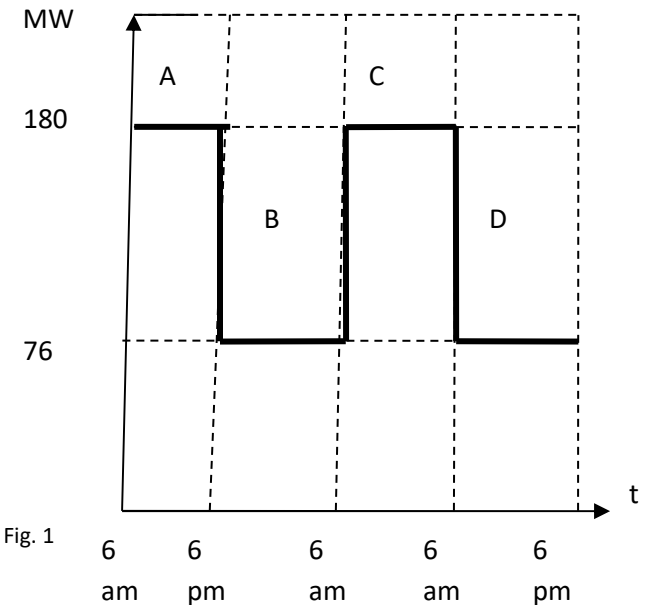

Fig. 1

i. Determine optimal load sharing between the two units in section B between the two units.

ii. If cost of taking a unit off the line line and returning it to the service after 12 hours is ksh. 200/-, determine whether it would be more economical to remove one unit from service for the 12 hours of light load. (10 marks)

b) Sketch a well labeled diagram of voltage regulator and turbine governor controls for a steam turbine generator. (5 marks)

c) Derive the expression of optimal distribution of loads between plants considering transmission losses in terms of plants outputs. (9 marks)

d) Briefly discuss three ways of line voltage regulation and compensation. (6 marks)

QUESTION TWO (20 MARKS)

a) Mention any three constraints in economic load dispatch. (3 marks)

b) A 1000MVA, 50-Hz turbine-generator has a regulation constant R=0.08 per unit based on its own rating. If the generator frequency increases by 0.005Hz in steady state, determine the decrease in turbine mechanical power output. (7 marks)

c) Using dynamic programming method, determine the most economical units to be committed for a load of 6 MW. Let the load changes be in steps of 1 MW. Equations for the cost curves of the two machines are:

$C_1 = 0.4P_1^2 + 24P_1;\ \ C_2 = 0.8P_2^2 + 26P_2.$ (10 marks)

QUESTION THREE (20 MARKS)

a) Mention factors that affect the failure rate and the repair rate of a power system. (3 marks)

b) Two synchronous generators operate in parallel and supply a total load of 600MW. The capacities of the machines are 300MW and 600MW and both have governor droop characteristic of 5% from no load to full load. Calculate the load taken by each machine, assuming free governor action. (7 marks)

c) Fig.2 is a daily load curve and table 1 is economical optimal unit commitment table for load curve using three units. Assuming identical failure rate λ of 2/year for the three units and repair rate μ of 98/year for all the three units, determine whether the system is secure for period B when supplying 4 MW. Assume maximum tolerable insecurity level (MTIL) to be 0.004. Minimum generation per unit is 1 MW and maximum generation per unit is 7 MW. (10 marks)

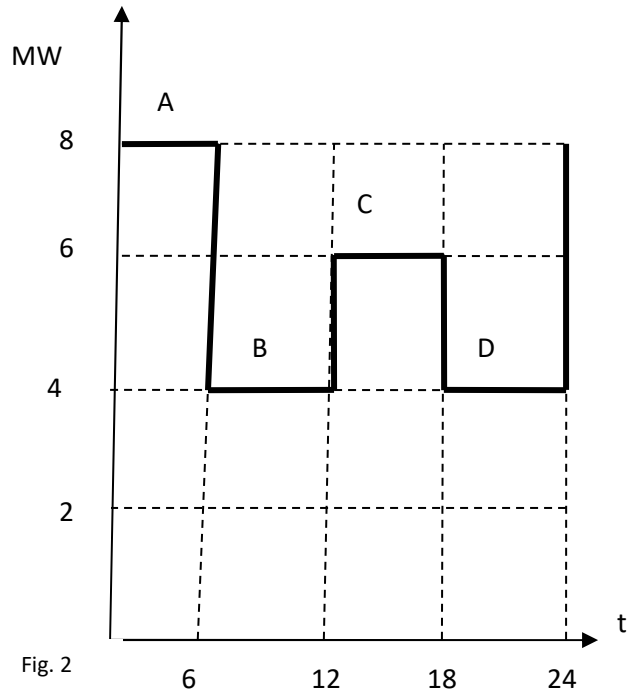

Fig. 2

Table 1

Period	Unit Number		
	1	2	3
A	1	1	1
B	1	0	0
C	1	1	0
D	1	0	0

QUESTION FOUR (20 MARKS)

a) The received reactive power can be given by the expression $Q_r = \frac{V_r}{X}(V_s - V_r)$. Briefly discuss the significance of this expression. (3 marks)

b) Briefly describe the effects of transmission losses on economical dispatch solution. (2 marks)

c) An area of interconnected power system has two fossil fuel units operating on economical dispatch. The variable operating costs of these units are given by:

$C_1 = 10 \times 10^{-3}P_1^2 + 15P_1$; $C_2 = 15 \times 10^{-3}P_2^2 + 10P_2$. The total losses are given by:

$P_L = 1.0 \times 10^{-4}P_1^2 + 2.5 \times 10^{-5}P_1P_2 + 4 \times 10^{-5}P_2^2\ MW$, where P_1 and P_2 are given in MW. When λ=20 $/MWhr, determine:

i. Output of each unit.
ii. Total transmission losses.
iii. Total load demand.
iv. Total operating cost. (15 marks)

QUESTION FIVE (20 MARKS)

a) One area of an interconnected 50 hertz power system has three turbine generator units rated 1500, 1200 and 800 MVA respectively. The regulation constant of each unit is R=0.05 per unit based on its own rating. Each unit is initially operating at half its own rating, when the system load suddenly increases by 300MW. Determine:

i. The per unit area frequency response characteristic β on 1500MVA system base.
ii. The steady state drop in area frequency.
iii. The increase in turbine mechanical power output of each unit

Assume that the reference power setting of each turbine generator remain constant. Neglect losses and dependence of load on frequency. (12 marks)

b) For the system shown in fig. three derive the expressions for the B coefficients. (8 marks)

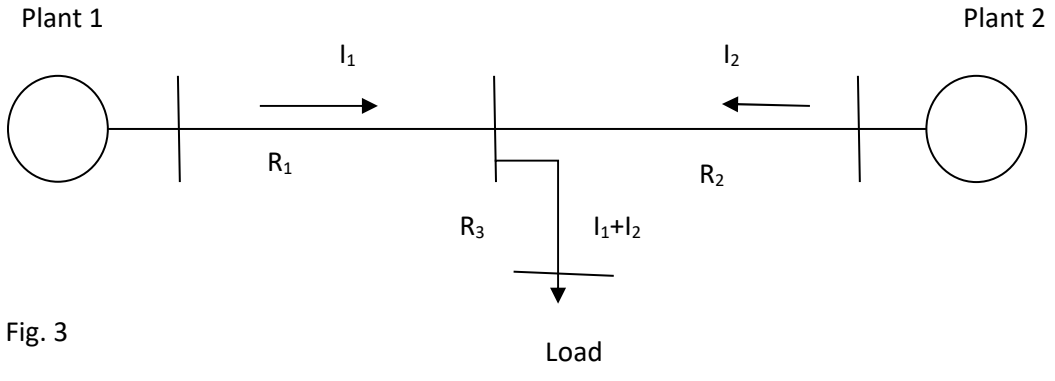

Fig. 3