TECHNICAL UNIVERSITY OF MOMBASA

FACUULTY OF ENGINEERING AND TECHNOLOGY

ELECTRICAL ENGINEERING DEPARTRMENT

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE2514: POWER SYSTEM ANALYSIS II

END OF SEMESTER EXAMINATION

SERIES: MAY 2016

TIME: 2 HOURS

DATE: Pick DateSelect MonthPick Year

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

a) Explain how the following power system devices are applied in grid voltage regulation:
   i. Tap changing auto transformer
   ii. Phase changing transformer
   iii. Induction Voltage Regulator

(3 Marks)

b)
   i. State any THREE functions of an Independent System Operator(ISO)
   ii. Explain any TWO reasons why such an operator in b(i) above is recommended to be a state agency

(5 Marks)

c)
   i. With the aid of a schematic diagram explain the functioning of a Turbine Governor Unit (TGU)
   ii. Compare the responses of TGU's for steam and hydro power generation plants

(8 Marks)

d) Fig 1 below shows a phase power transmission line

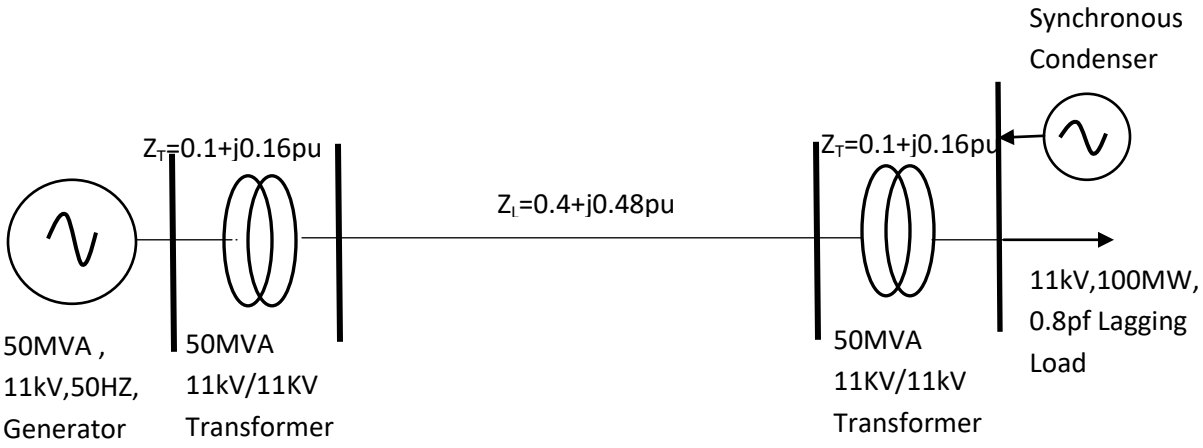

Fig 1

Given that impedances are per phase values on a 50MVA base, determine the MVA rating of Synchronous Condenser to be connected at the end of the transmission line as shown to have exact 11kV buses at both ends with the connected load.

(14 Marks)

Question TWO

a) Give TWO examples of each of the following in a power generating plant

i. Fixed cost
ii. Variable cost

(4 Marks)

b)

i. Highlight any THREE sources of inequality constraints on economic dispatch problem
ii. Explain the impact of transmission line losses on economic dispatch problems
iii. Describe how non-fossil fuel units are engaged for economic dispatch

(6 Marks)

c) The total transmission line losses for a power system is given by:

$P_{Losses}=3.0x10^{-4}P_1^2+4x10^{-4}P_1P_2+6x10^{-5}P_2^2$

Two units supplying power through the transmission line have incremental costs in thousand shillings is given by

$\frac{dC_1}{dP_1}=20+32x10^{-3}P_1$ Ksh/MWhr

$\frac{dC_2}{dP_2}=16+36x10^{-3}P_2$ Ksh/MWhr

Given that generator 1 outputs 800MW and, the area penalty factor λ is 32Ksh/MWhr. Find:-

i. the output of generator 2 and the total power output
ii. the total cost of power production

(10 Marks)

Question THREE

a) Define the following in relation to power generation:

i. Regulation Constant
ii. Inertia Constant
iii. Reference power settings

(3 Marks)

b) Explain why: -

i. steam generators are mostly suited for frequency stability compared to hydro turbines
ii. frequency control with synchronous machines is easily achieved wind and Solar PV systems

(4 Marks)

c) The control block diagram of Automatic Voltage Regulator(AVR) is as shown in Fig 1 below:

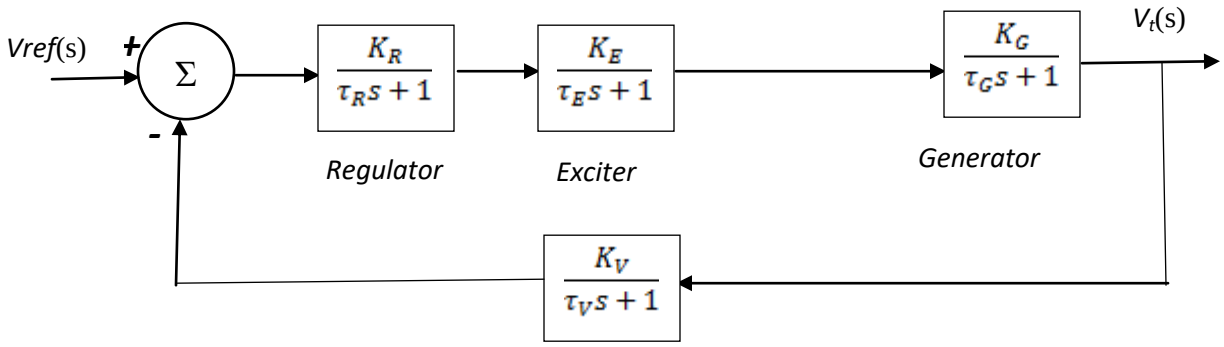

Fig 1

Given that τ_R=0.3s, τ_E=0.2s, τ_G=0.8s, τ_V=0.4s, and K_R=100, K_E=200, K_G=500, and K_v=4.5454X10^{-3}:

i. Determine the transfer function of the AVR system
ii. Find the steady state voltage error and the final terminal voltage of the generator corresponding to 50V step input
iii. Explain the effects of τ and K constants in the system

(13 Marks)

Question FOUR

a) Explain the following in power generation

i. Frequency dependent characteristic of a load
ii. Area frequency response characteristic
iii. Rotor frequency

(3 Marks)

b) Show with aid of droop sketches that for two generators in a system, the load picked by each generator following an increase of load is given by:

$$\frac{\Delta P_1}{\Delta P_2} = \frac{R_2}{R_1}$$

(6 Marks)

c) In a 50Hz interconnected power system, there are three generators rated 200, 150 and 100 MVA with corresponding regulation constants based on corresponding generator ratings of 0.03,0.06, 0.05 respectively. The frequency dependent characteristic of the load on a 200MVA base is 0.2. The load suddenly increased by 50 MW, assuming that each generator is operating at 5 % spinning reserve and 0.8 power factor leading, determine

i. The stiffness of the system(β)
ii. The steady state frequency error and the final frequency
iii. The power increase in each generator unit
iv. Whether the generators are capable of handling the contingency.

(11 Marks)

Question FIVE

a) Explain the following operations in a power system:

i. Islanding
ii. Load shedding
iii. Browning out

(3 Marks)

b) With the aid of control block diagram explain how Load Frequency Control(LFC) functions

(6 Marks)

c) Two areas in a 50Hz interconnected power system through a tie line is such that Area 1 generation capacity, load and area frequency response characteristic based on a 1000MW base are 500MW,450MW and 2000MW/Hz respectively, while Area 2 has 300MW generation 350MW load and β of 2500MW/Hz based on a 1000MW base. The load in Area 1 suddenly drops by 50MW. Assuming a 100% loading of generators, calculate:

i. Steady state frequency and new tie line power assuming no LFC was in place
ii. Steady state frequency and tie line power with LFC in place

(11Marks)