



# TECHNICAL UNIVERSITY OF MOMBASA

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FACULTY OF ENGINEERING AND TECHNOLOGY

ELECTRICAL ENGINEERING DEPARTMENT

## 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: 16, May 2016**

### 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.**

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### Question ONE (Compulsory 30 marks)

- a) Explain TWO causes of each of the following events in a power system
- Frequency rise
  - Voltage Decline

**(4 Marks)**

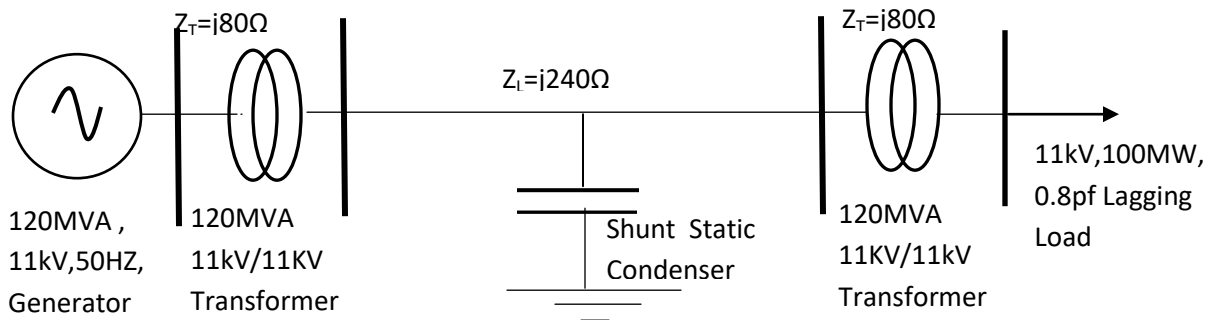
- b)
- Highlight any THREE roles of an electrical transmission company
  - Explain any TWO reasons why the company in b(i) is recommended to be distinct from a distribution company in same network

**(5 Marks)**

- c)
- State TWO advantages of Static Variable-reactor System (SVS) over Automatic Voltage Regulators(AVR's) when used for voltage control and regulation
  - With the aid of a sketch explain the principle of operation of AVR for a generator set

**(7 Marks)**

d) Fig 1 below shows a phase power transmission line



**Fig 1**

Determine the capacitance rating of static shunt condenser to be connected in the middle of the transmission line as shown to have exact 11kV buses at both ends with the connected load. The impedances shown are per phase values.

**(14 Marks)**

**Question TWO**

- a) Explain the following terms in power generation
- i. Operating Cost
  - ii. Incremental operating cost
  - iii. Fuel efficiency

**(3 Marks)**

- b)
- i. State TWO objectives of an economic dispatch problem
  - ii. Show THREE scenarios where economic dispatch problem is solved
  - iii. Explain how economic dispatch problem is coordinated with Load Frequency Control(LFC)

**(7 Marks)**

- c) TWO fossil fuel units are participating on economic dispatch to supply a 1.5GW load. The cost functions in thousands for each of the units are:

$$C_1 = 15 \times 10^6 P_1 + 12 \times 10^{-3} P_1^2 \text{ Ksh/hr}$$

$$C_2 = 12 \times 10^6 P_2 + 13.5 \times 10^{-3} P_2^2 \text{ Ksh/hr}$$

Given that the units are currently supplying 735MW load, neglecting generator limits and line losses determine:

- i. Output of the second generator
- ii. The incremental cost at minimum output cost
- iii. The minimum total operating cost

**(10 Marks)**

### Question THREE

- a)
- State the relationship between field current and reactive power output of a generator set
  - Explain TWO kinds of generator limits and corresponding causes

(6 Marks)

- b) The control block diagram of a Turbine Governor Unit(TGU) is as shown in Fig 1 below:

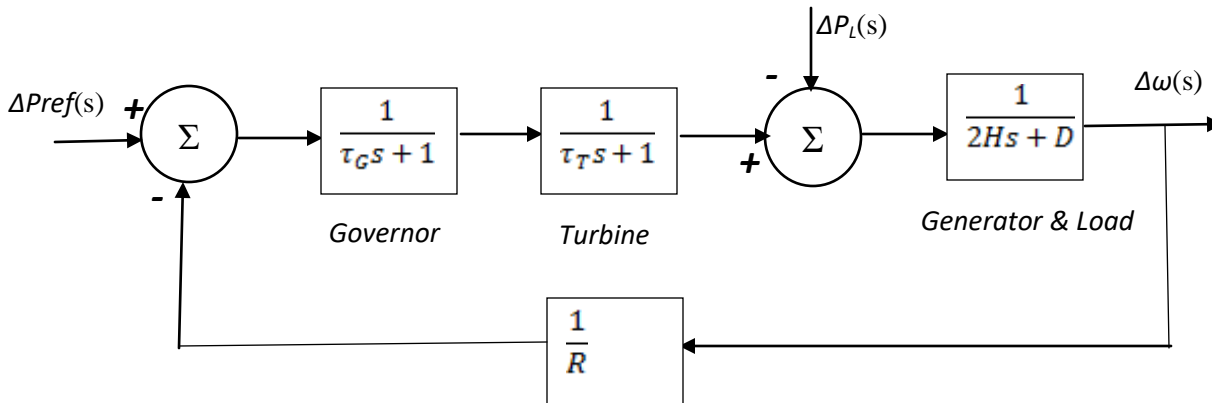


Fig 1

Given that  $\tau_G=0.5s$ ;  $\tau_T=0.6s$ ;  $H=2.5s$ ;  $R=0.04pu$ ;  $D=0.3pu$ ; and that the generator output rating is 250MW at 50Hz

- Reduce the control block diagram to a convenient form
- Find the final steady state frequency error and the final frequency if the generator load increases to 300Mwz
- Explain the significance of sizes of  $\tau$ ,  $H$ ,  $R$ , and  $D$  in the system

(14 Marks)

### Question FOUR

- a) Explain the meaning of the following in power generation
- Isochronous governor
  - Steady state frequency deviation
  - Primary response

(3 Marks)

- b) Show that the frequency bias factor  $\beta$  for a system with many generators is given by:

$$\beta = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots = \frac{1}{R_N} + D$$

(6 Marks)

- c) There are three generators in a 50Hz interconnected power system rated 500, 300 and 50 MW respectively. The regulation constant for each unit based on corresponding rating is 5% and the frequency dependent characteristic

of the load based on 500MW base is 0.3. The generators are operating with 5%, 10% and 30% spinning reserve respectively when the 50MW generator suddenly trips out of the system. Determine:

- i. The stiffness of the system( $\beta$ )
- ii. The steady state frequency error and the final frequency of the system
- iii. The increase in power output by each generator
- iv. Whether the generators are capable of handling the contingency.

**(11 Marks)**

### **Question FIVE**

a) Define the following terms for a power system:

- i. Tie line
- ii. Area control error
- iii. Power system area

**(3 Marks)**

b)

- i. State TWO objectives of Load Frequency Control (LFC)
- ii. Explain any FOUR power system conditions necessary for successful LFC

**(6 Marks)**

c) Given a 50 Hz interconnected power system with the following information:

**Area 1**

Generation=4000MW

$\beta$ =1400MW/hz

Load =4000MW

**Area 2**

Generation=3500MW

$\beta$ =1200MW/hz

Load =3500MW

A load of 500MW suddenly increases in Area 1, assuming no Load Frequency Control (LFC) was in place determine:

- i. The final steady state frequency
- ii. The tie line power before and after the event
- iii. The final steady state frequency and tie line power if LFC is in place

**(11 Marks)**