



MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

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

EEE 502: POWER SYSTEMS ANALYSIS

DATE: 4/8/2017

TIME: 2 HRS

INSTRUCTIONS:

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) List THREE advantages of per unit system. (3 marks)
- b) A transformer is rated 4000VA, 500V/100V and 0.1 pu impedance. What is the impedance of the transformer in ohms referred to:
 - i. High voltage side
 - ii. Low voltage side. (5 marks)
- c) Discuss three ways of improving power system stability. (3 marks)
- d) A 3-phase cylindrical generator is delivering 1.0 per unit power to infinite bus bars through a transmission network. The maximum power that can be transferred for fault, during fault and post fault conditions is 1.8pu, 0.4pu and 1.5pu. Find the critical clearing angle. (9 marks)
- e) Two synchronous generators operate in parallel and supply a total load of 400MW. The capacities of the machines are 200MW and 400MW and both have governor droop characteristic of 4% from no load to full load. Calculate the load taken by each machine, assuming free governor action. (6 marks)
- f) Formulate the $[Y_{bus}]$ for the network shown in fig.1. The values shown are admittances. (4 marks)

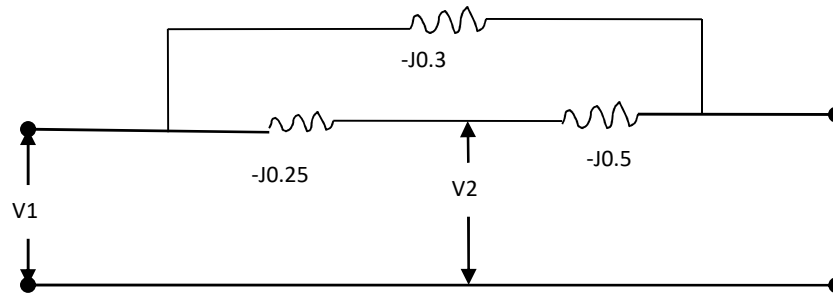


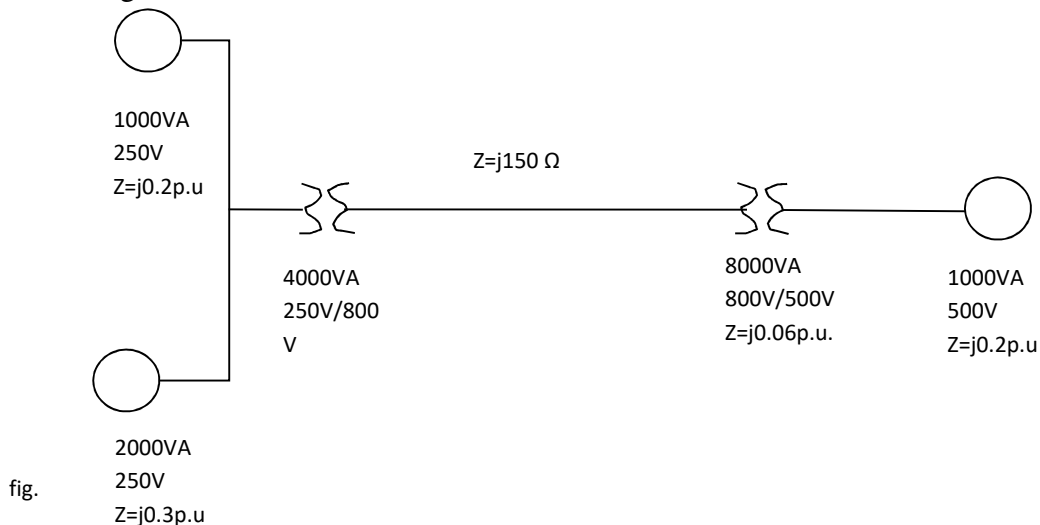
Fig.1

QUESTION TWO (20 MARKS)

a) Briefly discuss why:

- i. Transient stability is lower than steady state stability. (2 marks)
- ii. An early fault clearing means better chances of maintaining stability. (2 marks)

b) A simple power system is shown in fig.2. Redraw this system where pu impedances of the components are represented in a common base of 4000VA and a common base voltage of 250V at the generators. (9 marks)



c) A 500MVA, 60-Hz turbine-generator has a regulation constant $R=0.05$ per unit based on its own rating. If the generator frequency increases by 0.01Hz in steady state, determine the decrease in turbine mechanical power output. (7 marks)

QUESTION THREE (20 MARKS)

- a) State any two-basic load frequency control objectives for an interconnected power system. (2 marks)
- b) An area of an interconnected power system has two fossil fuel units operating on economic dispatch. The variable operating costs of these units are:
 $C_1 = 10P_1 + 8 \times 10^{-3}P_1^2 \text{ ksh/hr}$
 $C_2 = 8P_2 + 9 \times 10^{-3}P_2^2 \text{ ksh/hr}$
where P_1 and P_2 are in megawatts. Determine the power output of each unit, the incremental operating cost, and the total operating cost C_T that minimizes C_T as the load demand varies from 500 to 1500 MW in steps of 100 MW. (10 marks)
- c) A loss free alternator supplies 80MW to infinite bus bars. The maximum steady state limit of the system is 140MW. If the prime mover input is increased by 40% of the original value, determine whether the alternator will remain in synchronism. (8 marks)

QUESTION FOUR (20 MARKS)

- a) Derive the expression to prove that for economical division of load between units within a plant, all the units must operate at the same incremental fuel cost. (8 marks)
- b) The incremental fuel costs in ksh per MWhour for a plant consisting of two units are given by $\frac{dF_1}{dP_1} = 0.0080P_1 + 8.0$; $\frac{dF_2}{dP_2} = 0.0096P_2 + 6.4$. Determine the savings in fuel in ksh per hour for the economical distribution of a total load of 900MW between two units of the plant compared with equal distribution of the same total load. (7 marks)
- c) Briefly describe the effects of transmission losses on economical dispatch solution. (2 marks)
- d) Explain why Newton Raphson method is preferred to Gauss seidel method for load flow studies in power systems. (3 marks)

QUESTION FIVE (20 MARKS)

- a) The circuit in fig.3 shows a one line diagram of a power system. Find the maximum steady state power:
- When capacitor is connected. (4 marks)
 - When capacitor is replaced with an inductance of the same value. (4 marks)

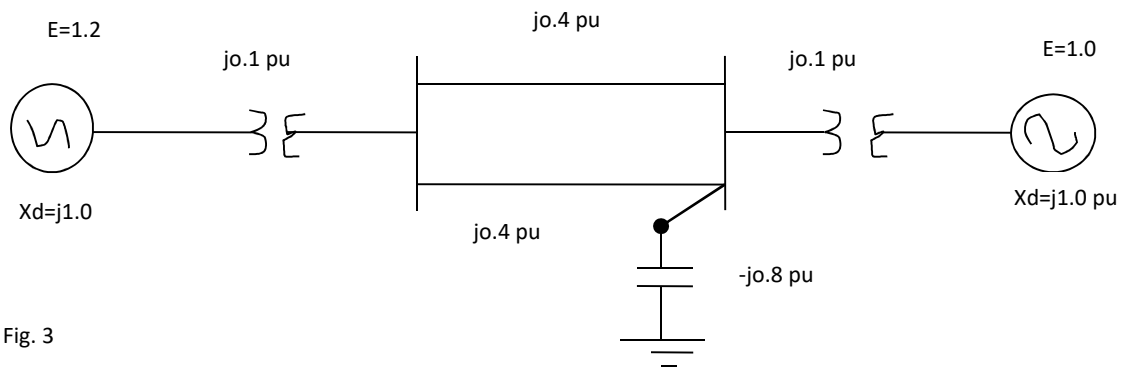


Fig. 3

- b) Differentiate between load, generator and slack busses in terms of specified quantities and unknown quantities. (6 marks)
- c) Find the value of x accurate up to 4 decimal places in the equation $2x - \log x = 7$ using Newton-Raphson method. Assume $x^0=1$. (6 marks)