UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

MAIN EXAMINATION DECEMBER 2015

TITLE OF PAPER:	POWER SYSTEM ANALYSIS AND OPERATIONS
COURSE CODE:	EE552
TIME ALLOWED:	THREE HOURS

INSTRUCTIONS:

1. Answer any five **(5)** questions
2. Each question carries 20 marks
3. Marks for different sections are shown in then right hand margin

This paper has 4 pages including this page

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QUESTION 1 [20]

(a) State 4 conditions for successful operation of a power system under normal balanced three-phase steady-state conditions **[4]**

(a) For the two bus power system shown in **Fig. Q. 1(b)**, use the Newton-Raphson power flow to determine the voltage magnitude and angle at bus two. Assume that bus one is the slack and $S_{Base} = 100$ MVA **[16]**

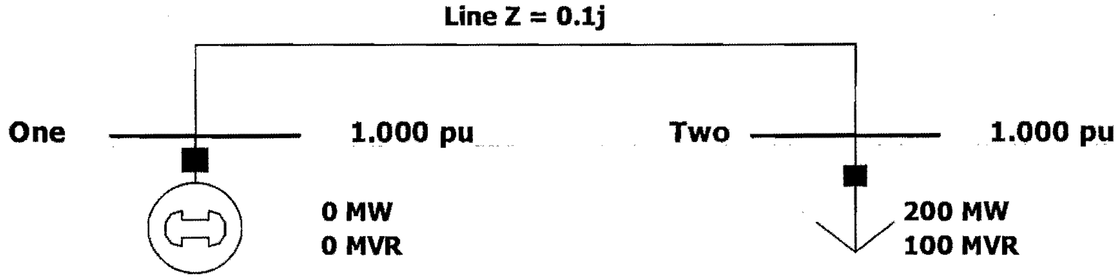

Fig. Q. 1(b).

QUESTION 2 [20]

(a) The single -line diagram for a simple three-phase power system is shown in **Fig. Q. 2 (a).** A bolted fault occurs at bus 3 (B3), with a pre fault voltage of 272 kV

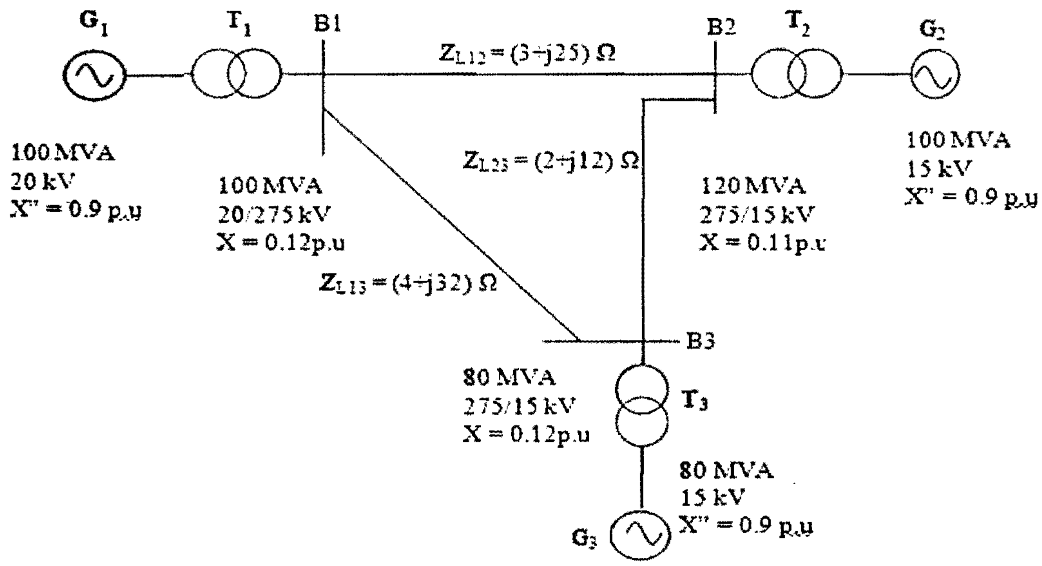

Fig. Q. 2(a).

(i) Calculate the Thevenin impedance at the fault point. Use a base of 120 MVA **[17]**
(ii) Determine the sub- transient ***L-L-L*** fault current in p.u and in kA **[3]**

QUESTION 3 [20]

(a) State and explain any 3 main parameters of a transmission line **[6]**

(b) A transmission line delivers a load of 50 MVA at 110 kV and p.f. 0·8 lagging. If the ABCD constants of the line are: $A = D = 0{\cdot}98 \angle 3°$; $B = 110 \angle 75°\ \Omega$;
$C = 0{\cdot}0005 \angle 80°$ S. Determine:

(i) Sending end voltage **[6]**
(ii) Sending end current **[4]**
(iii) Sending end power **[2]**
(iv) Efficiency of transmission. **[2]**

QUESTION 4 [20]

(a) Define fault and state at least two common causes of fault **[3]**
(b) State 2 methods of computing fault current **[2]**
(c) Differentiate between balanced and unbalanced faults **[2]**
(d) Define symmetrical components and briefly explain how symmetrical components is used to analyze unbalanced systems **[4]**
(e) Compute the sequence components of the following balanced line – to- neutral currents with abc sequence **[9]**

$$\begin{bmatrix} I_{AN} \\ I_{BN} \\ I_{CN} \end{bmatrix} = \begin{bmatrix} 150\angle 45° \\ 250\angle 150° \\ 100\angle 300° \end{bmatrix} \; Amps$$

QUESTION 5 [20]

(a) Using two port network approach, derive the expressions for ABCD constants of a medium transmission line modeled using nominal π representation **[7]**

(b) Which of the following will increase the resistance of a transmission line? Briefly explain

(i) Increasing line temperature **[2]**
(ii) Moving from a 60Hz ac system to a 50Hz ac system **[2]**

(c) From hydroelectric power plant, 900 MW are to be transmitted to a load center located 500 km from the plant. Based on practical line loadability criteria, determine the number of 3 – phase 60 Hz lines required to transmit this power with one line out of service for the following cases

(i) 345 kV lines with $Z_C = 295\ \Omega$ [3]

(ii) 500 kV lines with $Z_C = 277\ \Omega$ [3]

(iii) 765 kV lines with $Z_C = 266\ \Omega$ [3]

Assume $V_S = 1.0$ per unit $V_R = 0.95$ per unit and $\delta = 35°$. Also assume that the lines are uncompensated.

QUESTION 6 [20]

(a) Discuss a basic procedure used in solving a power flow problem using Gauss-Siedel iterative method [7]

(b) In a 2-bus power system shown in **Fig Q. 6(b),** a generator attached to bus 1 and loads attached to bus 2. The series impedance of a single transmission line connecting them is (0.1+j0.5) per unit. The shunt admittance of the line may be neglected. Assume that bus 1 is the slack bus and that it has a voltage $V_1 = 1.0\angle 0°$ per unit. Real and reactive powers supplied to the loads from the system at bus 2 are $P_2 = 0.3$ per unit, $Q_2 = 0.2$ per unit (powers supplied to the system at each busses is negative of the above values). Determine voltages at each bus for the specified load conditions. ***Use the Gauss-Siedel iterative method*** [13]

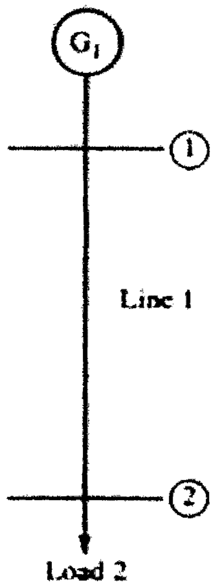

Table of Busses:

Bus 1	Slack bus
Bus 2	Load bus

Fig. Q. 6(b)