Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH (ELECTRICAL & ELECTRONICS ENGINEERING)

MAKE-UP EXAMINATIONS, DECEMBER 2019

SUBJECT: POWER SYSTEM ANALYSIS [ELE 3105]

Time : 3 Hours **Date: 30 December 2019** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.

1A. Two generators operate in parallel supplying a motor through a transmission line having transformers at both the ends. There are lagging loads at the generator and motor terminal buses. Draw a single line diagram of the sample power system described above. Also draw reactance diagrams of the system for (i) A load flow study (ii) Fault analysis, justifying the assumptions made. ***(04)***

1B. The system shown in Fig. 1B is delivering 50 MVA at 11 KV, 0.8 power factor lagging into a bus which may be regarded as infinite. Particulars of various system components are:

Generator : 60 MVA, 12 KV, $X_d' = 0.35$ pu

Transformers (each) : 80 MVA, 12/66 KV, X = 0.08 pu

Line : Reactance 12 Ω, Resistance negligible

Calculate the momentary current that the circuit breakers A and B will be called upon to interrupt in the event of a 3-phase fault occurring at F near the circuit breaker B. Use Thevenin's method and assume base of 80 MVA, 12 KV in the generator circuit.

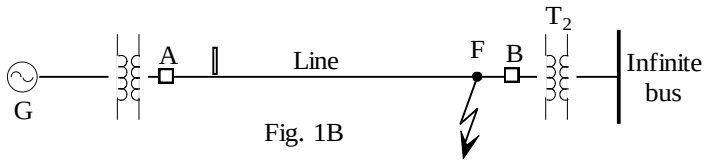

Fig. 1B

(06)

2A. A generator-transformer unit is connected to a line through a circuit breaker. The unit ratings are generator 10MVA, 6.6KV, $X_d''=0.1$pu, $X_d'=0.2$pu, $X_d=0.8$pu. Transformer 10MVA, 6.9/33 KV, reactance=0.08 pu. The system is operating on no load at a line voltage of 30 KV, when a three-phase fault occurs on the line just after the circuit breaker. Assuming base of 10 MVA, 6.9 KV in the generator circuit, determine

i. Initial symmetrical r.m.s. current in the circuit breaker.
ii. Maximum possible dc offset current in the breaker
iii. Momentary current rating of the breaker
iv. Current to be interrupted by the breaker and interrupting MVA
v. Sustained short circuit current in the breaker. ***(05)***

2B. Compute the sequence components of Va if $Va=1.7088\angle 24.18°$, $Vb=0.4\angle 90°$ and $Vc=1.7088\angle 155.82°$. Assume abc sequence. ***(02)***

2C. With a neat sketch, explain phase shift in Y-Δ transformer where HV side is Y connected. Draw relevant phasor diagrams to show the relationship between sequence components of Y and Δ side quantities. ***(03)***

3A. A double line to ground fault occurs on lines b and c of an unloaded synchronous generator with its neutral grounded through impedance Z_n. i) Write down the equations describing the fault ii) Derive the expression for fault current iii) Derive the expression for voltage V_a iv) Show the inter connection of the sequence network to represent the fault. The sequence impedances of the generator are Z_1 , Z_2 and Z_{go}. ***(04)***

3B. Consider the power system shown in Fig. Q 3B. Both the machines operate at rated voltage and each has X_1=0.15 pu, X_2=0.1 pu and X_0=0.06 pu. A single line to ground fault occurs at point F which is the midpoint of the line. (i) Draw the sequence networks, (ii) Compute the thevenin's impedances and (iii) Calculate the fault current and current in phase *a* of both the generators.

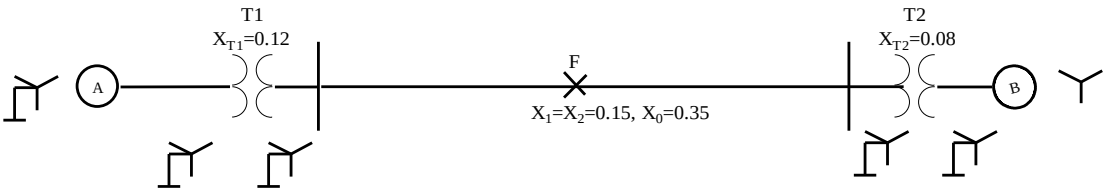

Fig. Q 3B ***(06)***

4A. A 50 Hz, Synchronous generator has H=5 MJ/MVA, and Xd'=0.3 p.u. It is connected to an infinite bus transferring 1 p.u power through a transformer and a double circuit line. The transformer reactance is 20 %. Each line has a reactance of 30 %. The voltage behind transient reactance of generator is 1.17p.u. A three phase fault occurs at the middle of one of the lines. The fault is cleared by the opening of the faulted line. Determine the critical clearing angle and critical clearing time. ***(05)***

4B. A 200MVA, 11Kv 50Hz, 6 pole generator has an inertia constant of 5MJ/MVA. The machine is operating at a load of 120MW when the load is suddenly increased to 150MW. Find the rotor retardation. If the retardation is maintained for 10 cycles, find the speed at the end of this period. ***(03)***

4C. Distinguish between steady state and transient stability and explain the methods to improve the transient stability ***(02)***

5A. In the power system shown in Fig.5A, the line impedances are marked in per unit on a 100MVA base. Using the Gauss-Seidel method, determine the voltage at the buses 2 and 3 and use two iterations.

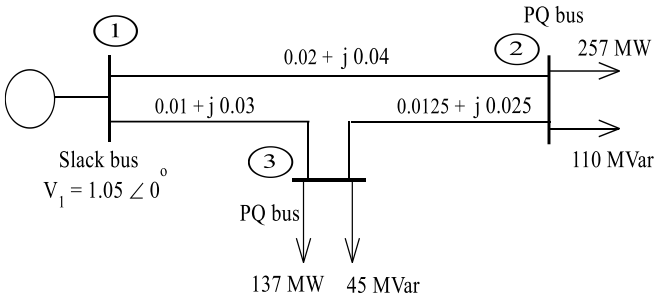

Fig.5A ***(06)***

5B. Using matrix algebra, eliminate node-3 in the network shown in Fig. 5B and draw the reduced network. The values on figure represent reactances in p.u on a common base.

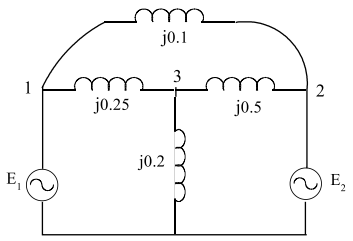

Fig. 5B ***(04)***