

International Islamic University Chittagong

Department of Electrical and Electronic Engineering

B.Sc. Engineering in EEE

Final Exam, Autumn 2021

Course Code: **EEE-3519**

Course Title: **Power System Analysis**

Time: **2 hours 30 minutes**

Full Marks: **50**

(i) The figures in the right-hand margin indicate full marks

(ii) Course Outcomes and Bloom's Levels are mentioned in additional Columns

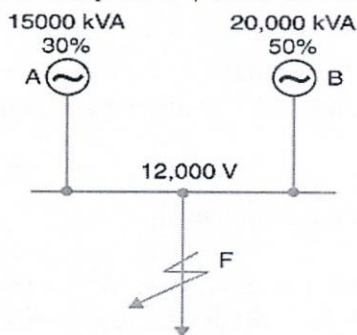
Course Outcomes (COs) of the Questions	
<i>Upon the successful completion of the course, students will be able to</i>	
CO1	Reflect a basic understanding of power system modelling, effects of synchronous machines in power system, one-line diagram, network calculations, bus impedance matrix, different types of power system faults and fault calculations.
CO2	Understand the application of load flow methods such as Gauss-Seidel method and Newton-Raphson method, and application of symmetrical components in power system.
CO3	Solve power system networks under different fault and load conditions.

Bloom's Levels of the Questions						
Letter Symbols	R	U	App	An	E	C
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

Part A

[Answer the questions from the following]

1. a) (i) Whatever may be the value of base kVA, short-circuit current is the same- Justify the statement. **CO1 An, 4+2=6**
 (ii) In a 3- ϕ system, it has been found that the negative sequence components and the zero sequence components are absent. Is it a balanced system? Represent the phase currents of this system using sequence components. **U.**
1. b) Fig.1 shows the single line diagram of a 3- ϕ system. Find the short circuit current that will flow into a complete 3- ϕ short-circuit at F, shown in Fig. 1. **CO3 E 4**



Single-line diagram
(i)

Fig. 1

2. a) (i) When any unsymmetrical fault occurs, there is no chance of flowing zero sequence current in **Delta** connected load - Justify. CO2 U, 3+3=6
An
- (ii) Draw the zero-sequence network of the following system in Fig. 2.

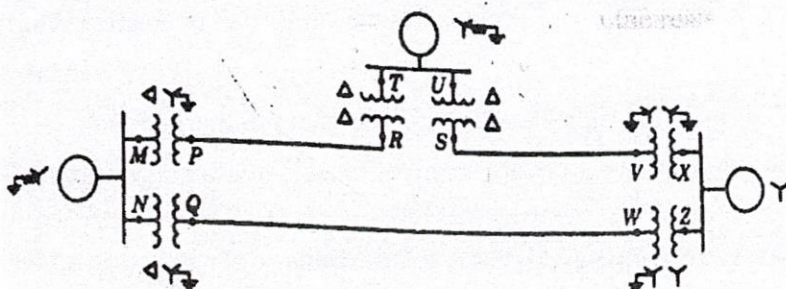


Fig. 2

2. b) A balanced star connected load takes 90 A from a balanced 3-phase, 4-wire supply. If the fuses in the Y and B phases are removed, find the symmetrical components of the line currents CO3 E 4
- (i) before the fuses are removed (ii) after the fuses are removed

Or,

2. a) (i) When any unsymmetrical fault occurs, there is no chance of flowing zero sequence current in a **Star** connected load where neutral is not connected to ground - Justify. CO2 U, 3+3=6
An
- (ii) Draw the zero-sequence network of the following system in Fig. 2.

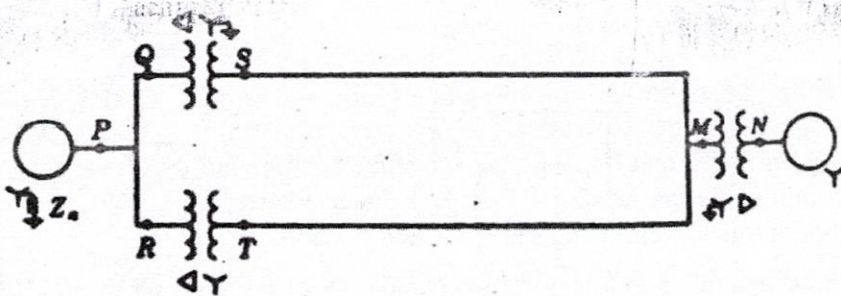


Fig. 2

2. b) The currents in a 3-phase unbalanced system are: CO3 E 4
 $I_R = (12 + j 6) A$; $I_Y = (12 - j 12) A$; $I_B = (-15 + j 10) A$
 The phase sequence in RYB. Calculate the zero, positive and negative sequence components of the currents.

Part B

[Answer the questions from the followings]

3. a) Construct the sequence network, and deduce the expression of currents if Line-to-Ground (L-G) fault occurs between two phase of a star connected Synchronous Machine. CO3 U 5

3. b) A salient pole generator without dampers is rated 20 MVA, 13.8 kV and has a direct axis sub-transient reactance of 0.25 p.u. The negative and zero sequence reactance are 0.35 p.u. and 0.10 p.u. respectively. The neutral of the generator is solidly grounded. Determine the sub-transient currents and line-to-line voltages when line-to-Ground (L-G) fault occurs at the terminals of the generator. Assume that the generator is unloaded and operating at rated terminal voltage when the fault occurs. Neglect the resistance.

CO3 E 5

Or,

3. a) Construct the sequence network and deduce the expression of currents if Line-to-Line fault occurs between two phase of a star connected Synchronous Machine.

CO3 App 5

3. b) A salient pole generator without dampers is rated 20 MVA, 13.8 kV and has a direct axis sub-transient reactance of 0.25 p.u. The negative and zero sequence reactance are 0.35 p.u. and 0.10 p.u. respectively. The neutral of the generator is solidly grounded. Determine the sub-transient currents and line-to-line voltages when line-to-line fault occurs at the terminals of the generator. Assume that the generator is unloaded and operating at rated terminal voltage when the fault occurs. Neglect the resistance.

CO3 E 5

4. a) (i) What is Power angle curve of stability analysis? Deduce the mathematical expression.

CO1 App 4+1=5

(ii) What is the significance of M constant in Synchronous Machine?

4. b) A loss free generator supplies 50 MW to an infinite bus, the steady state limit of the system is 110 MW. Determine whether the generator will remain in synchronism if the prime mover input abruptly increased by 40 MW.

CO1 E 5

5. a) (i) What factors affect the transient stability of a Synchronous Machine?
(ii) Explain the methods that can improve the transient stability of a Synchronous Machine.

CO2 U, Au 1+4=5

5. b) A generator is delivering 60% of maximum power to an infinite bus through a transmission line. A fault occurs such that the reactance between generator and infinite bus is increased to three times its pre fault value. When the fault is cleared, the maximum power that can be delivered is 80% of its original value. Determine the critical clearing angle (δ_{cr}) and critical clearing time (t_{cr}). Where, H is 5 MJ/MVA and $\omega_s = 377$ rad/s

CO2 E 5