

International Islamic University Chittagong

Department of Electrical and Electronic Engineering

B.Sc. Engineering in EEE

Semester End Exam, Spring 2024

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

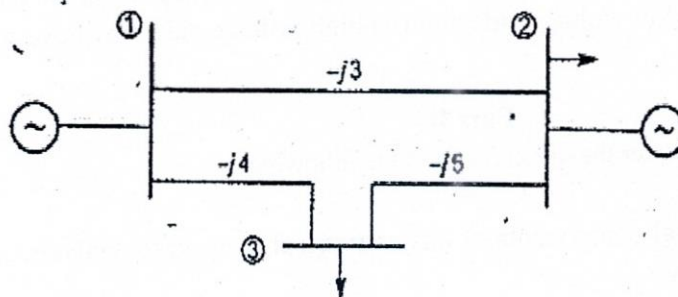
Course Outcomes (COs) of the Questions	
CO1	Reflect a basic understanding of power system modelling, effects of synchronous machines in power system, one-line diagram, network calculations, bus impedance matrix, different types of power system faults and fault calculations.
CO2	Understand the application 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	C1	C2	C3	C4	C5	C6
Meaning	Remember	Understand	Apply	Analyze	Evaluate	Create

Part A

[Answer the questions from the followings]

- Evaluate the values of C_k and D_{ki} are computed in the beginning and then used in every iteration using Gauss-Seidel method? CO2 C5 5
 - A 3-bus power system shown in the Fig. 1. The relevant p.u line admittances on 100 MVA base are indicated on the diagram and bus data are given in the table.
(i). Form Y bus and determine V_2 and V_3 after second iteration using Gauss-Seidal Method. Use $\alpha = 1.5$.
(ii). Also find the slack bus real and reactive power.



Bus number	Type	Generation		Load		Bus voltage	
		P_G (MW)	Q_G (MVAr)	P_L (MW)	Q_L (MVAr)	V pu	δ deg.
1	Slack	?	?	0	0	1.02	0°
2	PQ	25	15	50	25	?	?
3	PQ	0	0	60	30	?	?

Fig. 1

2. a) i) Define the terms 'percentage reactance' and 'short circuit KVA'.
 ii) Whatever the value of base KVA we may choose, the value of short-circuit current is the same-Justify the statement for the circuit shown in Fig. 2.

CO1 C3 2+3

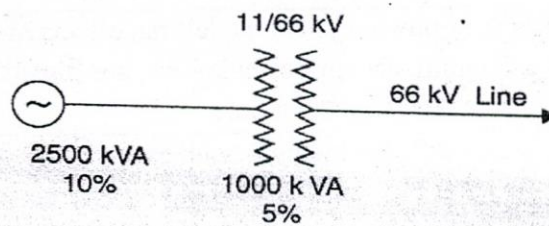


Fig. 2

2. b) i) Analyze the benefits of using reactors in tie-bar system to control the short-circuit current.
 ii) A 3-phase, 20 MVA, 10 kV alternator has internal reactance of 5% and negligible resistance. Identify the external reactance per phase to be connected in series with the alternator so that steady current on short-circuit does not exceed 8 times the full load current.

CO1 C4 2+3

Or,

2. a) Discuss the advantages of reactor control for short-circuit currents. What are the steps that are needed to be followed for symmetrical fault calculations?
 2. b) The plant capacity of a 3-phase generating station consists of two 10,000 kVA generators of reactance 12% each and one 5000 kVA generator of reactance 18%. The generators are connected to the station bus-bars from which load is taken through three 5000 kVA step-up transformers each having a reactance of 5%. Determine the maximum fault MVA which the circuit breakers on (i) low voltage side and (ii) high voltage side may have to deal with.

CO1 C3 2+3

CO1 C4 5

Part B

[Answer the questions from the followings]

3. a) Deduce the symmetrical components of unsymmetrical phasors to analyze an unbalanced 3- ϕ system.

CO3 C4 5

3. b) One conductor of a 3-phase line is open. The current flowing to the Δ -connected load through the line R is 20 A. With the current in line R as reference and assuming that line B is open, find the symmetrical components of the line currents: (i) before the fuses are removed (ii) after the fuses are removed CO3 C5 5
4. a) Construct the sequence network, and deduce the expression of currents if Double Line-to-Ground (L-L-G) fault occurs between two phase of a star connected Synchronous Machine. CO1 C3 5
4. 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. Evaluate the sub-transient currents and line-to-line voltages when Double Line-to-Ground (L-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. CO1 C4 5
5. a) (i) What is transient stability? CO3 C3 1+4
(ii) Show that, $M \frac{d^2\delta}{dt^2} = P_a = P_s - P_e$ gives the relation between the accelerating power and angular acceleration using swing equation?
5. b) (i) What you mean by Power angle curve CO3 C4 1+4
(ii) A double circuit three phase feeder connects a single generator to a large network. The power corresponding to the limit of stability for each circuit is 110 MW. The line is transmitting 90 MW when one of the circuit is suddenly switched out. Determine with reference to appropriate diagram whether the generator is likely to remain in synchronism.
- Or,**
5. a) i) What factors affect the transient stability of a Synchronous Machine? CO3 C3 2+3
ii) Explain the methods that can improve the transient stability of a Synchronous Machine.
5. b) A generator with constant excitation supplies 30 MW through a step-up transformer and a high voltage line to an infinite bus-bar. If the steady-state stability limit of the system is 60MW, estimate the maximum permissible sudden increase of generator output (resulting from a sudden increase in prime mover input) if the stability is to be maintained. The resistances of the generator, transformer and line may be neglected. CO3 C4 5