

ELL363: Power Engineering – II
Major Examination, Odd Semester, 2022-2023
Department of Electrical Engineering, IIT-Delhi

Total Marks: 50

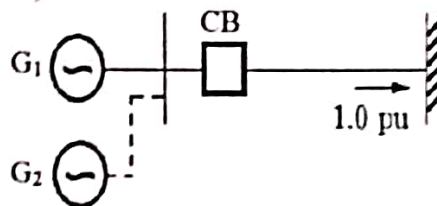
Duration: 2 hrs

Q1.

- a) State the condition for active power transfer limit through a transmission line. Find the steady state power transfer limit of a system consisting of a generator of 0.5 p.u. reactance connected to an infinite bus through a series reactance of 1.0 p.u. The terminal voltage of the generator is held at 1.2 p.u. and the voltage of infinite bus is 1.0 p.u.

(0.5+1.5) marks

b) .



In the figure shown above, "A synchronous generator transfers 1.0 p.u. of power to the infinite bus. The critical clearing time of circuit breaker is 0.28 s. If another identical synchronous generator is connected in parallel at the same bus to the existing generator, and each generator is scheduled to supply 0.5 p.u. of power, then calculate the critical time of the circuit breaker operation

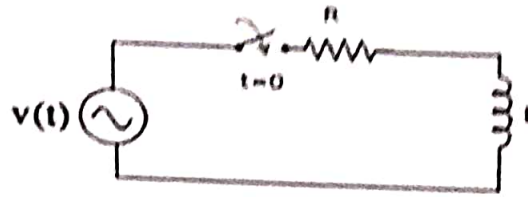
(0.5+1.5) marks

- c) The electrical power is transmitted over a transmission line with a speed equal to speed of light. What would be the wave-length of electromagnetic wave for Indian and USA power system? Justify your answer writing necessary formula.

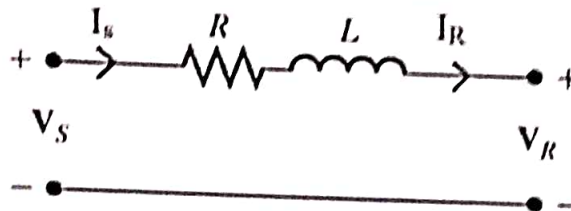
1 mark

Q2.

- a) A voltage source, $v(t) = V_m \sin(\omega t + \alpha)$, connected to an R-L circuit which is highly inductive in nature is shown in figure below.



- i. The switch is closed at $t=0$. Determine the instant of voltage waveform at which the instantaneous current is maximum. **2 marks**
 - ii. Consider the switch is closed at $t=0$. For $R = 0.01 \Omega$ and $L = 1.5 \text{ mH}$, determine the current expression at $t=0^+$. **0.5 marks**
- (b) State True/False and Justify the statement.
 "In the event of three-phase short circuit at the terminal of a synchronous generator (SG), the power factor of SG is unity". **1 mark**
- (c) A 60 km transmission line is represented as below.



The same line is extended to 100 km. Re-draw the figure with necessary modification and justify. **1.5 marks**

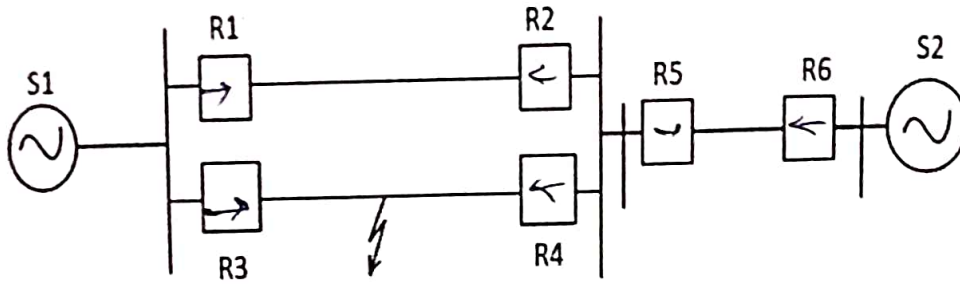
Q3.

- a) Maximum rated current of a radial feeder is 900 A, with 10% overload possibility. It is desired to operate an IDMT relay within 2 sec, for a fault current of 8kA. What should be the Time Multiplier Setting (TMS) of the relay? The CT ratio is 1000/1 A. Relay characteristics are given by

$$t_{op} = \frac{0.14 \times TMS}{PSM^{0.02} - 1}$$

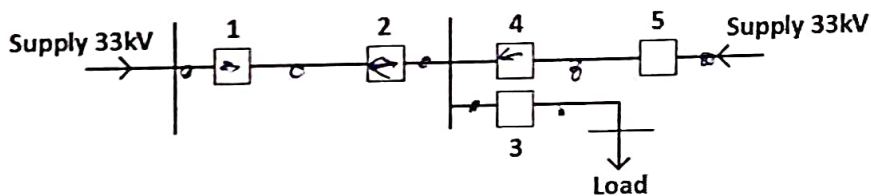
1 mark

- b) The power system shown below is protected by six overcurrent relays R1 to R6. Assuming a mix of directional and non-directional relays at appropriate locations, the remote backup relays for R4 are (choose option). Justify your answer. **(0.5+1.5) marks**



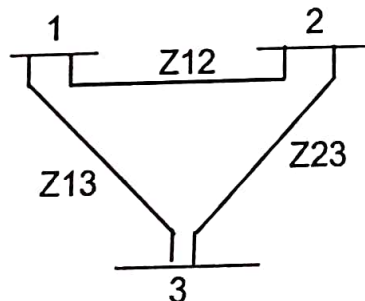
- i. R1, R2
- ii. R2, R6
- iii. R2, R5
- iv. R1, R6

c) The distribution system is to be protected by Overcurrent system of protection. For an accurate fault discrimination, which location will need Directional Overcurrent Relays? Justify your answer. (0.5+1.5) marks



- i. 1 and 5 only
- ii. 2 and 4 only
- iii. 1, 5 and 3
- iv. 2, 4 and 3

Q4. Find Y_{BUS} for the following system. Given $Z_{12} = 10 + j40$; $Z_{13} = 5 + j25$; $Z_{23} = 15 + j90$.



5 marks

Q5.

a) The point of intersection of demand curve and supply curve is the market clearing price. Explain graphically. 1.5 marks

b) Present day Indian electricity market is deregulated. Explain point wise reasons for deregulation. **1.5 marks**

c) State law of diminishing marginal utility. Explain with proper example. **2 marks**

Q6. State True/False and Justify.

a) Crow bar protection is generally used to protect Type-1 wind turbine generator from the fault happening at the PCC (point of common coupling). **(0.5 + 0.5) marks**

b) The field winding reactance is included in total reactance of a synchronous generator during transient period. **(0.5 + 1.5) marks**

c) Transient time constant is larger than the sub-transient time constant of a synchronous generator. **(0.5 + 1.5) marks**

Q7.

a) State True/False and Justify. "The inrush current of a transformer at no load is maximum if the supply voltage is switched on at peak voltage." **(0.5 + 1.5) marks**

b) An oil circuit breaker is operating at 11 kV with the rupturing capacity of 500 MVA. Find out the asymmetrical breaking capacity assuming 50 % dc component at the instant of short-circuit. **2 marks**

c) State True/False and Justify. "The Jacobian used in case of load flow can have 'complex' entries in it." **(0.5 + 0.5) marks**

Q8. State True/False and Justify

a) The PV array configuration should ensure that the DC current and DC voltage limits at the input of the inverter are respected. **(0.5+1.5)marks**

b) During malfunctioning of inverters in a grid-connected system, micro inverters has disadvantage of increasing down time as compared to single inverter system. **(0.5 + 1.5) marks**

c) FDLF is more prone to failure as compared to full NR method, while obtaining load flow solution on distribution system. **(0.5 + 1.5) marks**