UNIVERSITY OF SWAZILAND

SUPPLEMENTARY EXAMINATION, SECOND SEMESTER

JULY 2017

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

TITLE OF PAPER: Fundamentals of Power Engineering

COURSE CODE: EE351

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1. There are four questions in this paper. Answer ALL questions. Each question carries 25 marks.
2. If you think not enough data has been given in any question you may assume any reasonable values.

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THIS PAPER CONTAINS FIVE (5) PAGES INCLUDING THIS PAGE

QUESTION ONE *(25 marks)*

(a) Can a wattmeter that has current through its current coil and a potential across its coil, indicate zero? Explain [5]

(b) Two watt-meters are used to measure the total power in a three phase star connected load.

i. Copy and Complete the diagram in figure Q.1 to show the connection on these meters. [6]

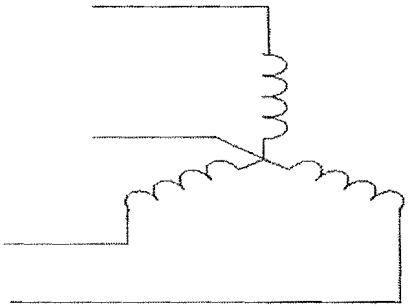


Figure Q.1

(c) Given that the two watt-meters in (i) indicate *100 kW* and 83 *kW* respectively when connected to measure the input power to a 3-phase balanced load, the *reverse switch being operated on* the meter indicating the 83 kW reading. Determine :

(i) The input power. [3]

(ii) The load power factor [5]

(d) Explain effect of poor power factor on efficiency and voltage regulation of transmission line. [6]

QUESTION TWO *(25 marks)*

(a) Figure Q.2 shows a balanced, star-connected load of phase impedance 45 Ω and power factor 0.8 lagging, supplied from the delta-connected secondary of a 3-phase transformer. The turn's ratio of the transformer is 16:1, and the star-connected primary is supplied at 11 kV.

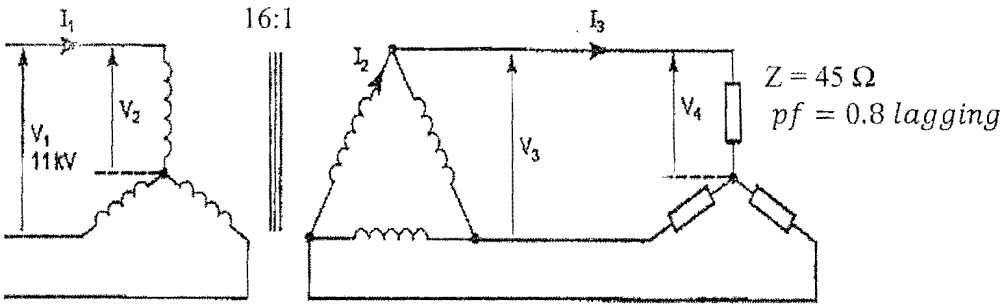


Figure Q.2

Determine:

i. The voltages V_2 , V_3 and V_4 , [6]

ii. The currents I_1, I_2 , and I_3 [6]

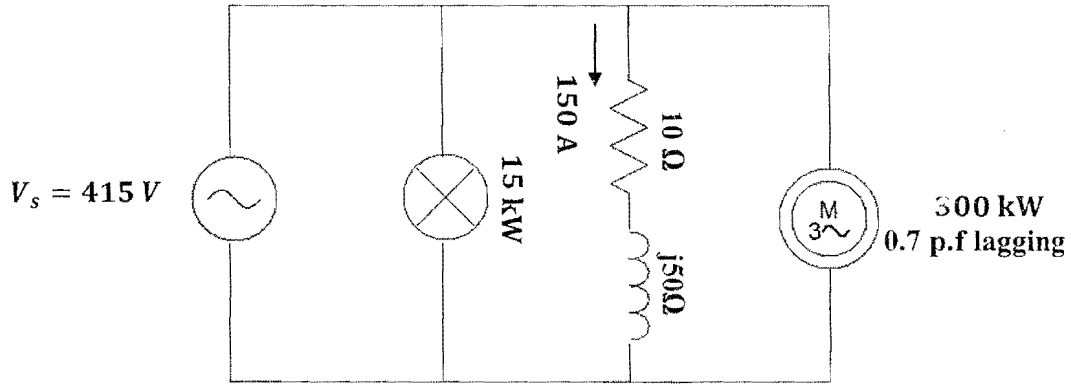
iii. The power drawn from the supply. [3]

(b) A 3 phase 1600 kVA, star-connected, 50 Hz, 2400 V alternator has a resistance between each pair of terminals as measured by direct current is 0.32 Ω. Assume that the effective resistance is 1.5 times the Ohmic resistance. A field current of 80 A produces a short circuit current equal to full load current 380 A in each line. The same field current produces an e.m.f of 700 V on open circuit.

Determine the synchronous reactance of the machine? [10]

QUESTION THREE *(25 marks)*

(a) An industrial client is charged a penalty of E 4 800 / 0.1 p.f deviation per annum, if the plant power factor drops below 0.85 and will be compensated E 1 000 / 0.1 p.f deviation per annum if the plant power factor is above 0.85. The equivalent plant loads are as shown below:



(i) What type of tariff is described in (a)? [1]

(ii) Calculate the annual penalty charges for this plant? [13]

(b) If the client in (a) uses 150 0000 units per year, Given that the tariff is E 350 plus E 75 per kVA, of maximum demand plus E0.50 per kWh.

(i) What type of tariff is described in (b) ? [1]

(ii) Calculate the annual cost of operating this plant? [2]

(iii) Calculate annual savings by installing a capacitor bank costing E80 per kVar which rises the power factor to 0.95 lagging. NB. Allow 20% per year cost of capacitor to cover additional costs. [8]

QUESTION FOUR (25 *marks*)

(a) Draw the per-unit reactance diagram for the 3_{Φ} shown in Figure Q4. Choose 100 MVA [13]

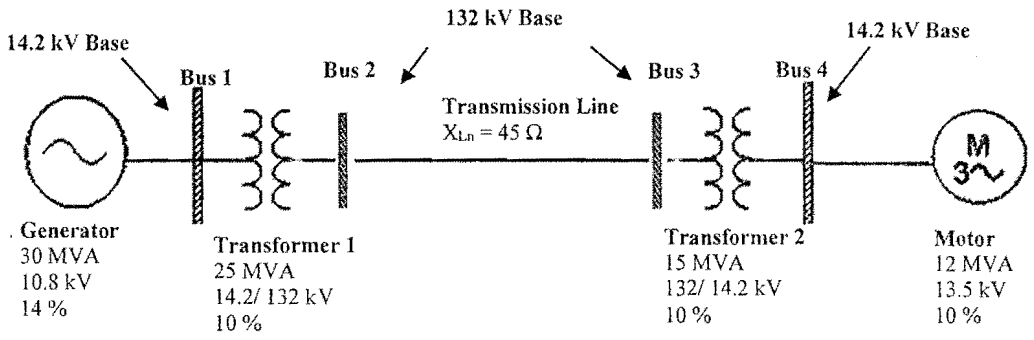


Figure Q 4(a)

(b) Calculate the per-unit voltages given the measured values in each bus as indicated in the table below. [4]

Bus	Measure Voltage (kV)
1	14.3
2	129.8
3	128.9
4	13.8

(c) Calculate the voltage regulation of this transmission line. [1]

(d) Name the components labelled on the oneline diagram shown in Figure Q4(b) [7]

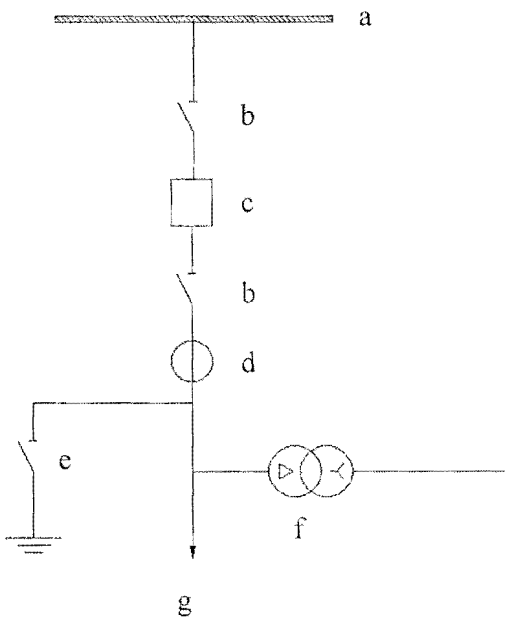


Figure Q 4(b)