ISSUED ON

17 JAN 2014

Engineering Tripos Part IB SECOND YEAR

Part IB Paper 5: Electrical Engineering

ELECTRICAL POWER

Examples Paper 3 : Three Phase

Straightforward questions are marked †
*Tripos standard questions are marked **

Revision

1.

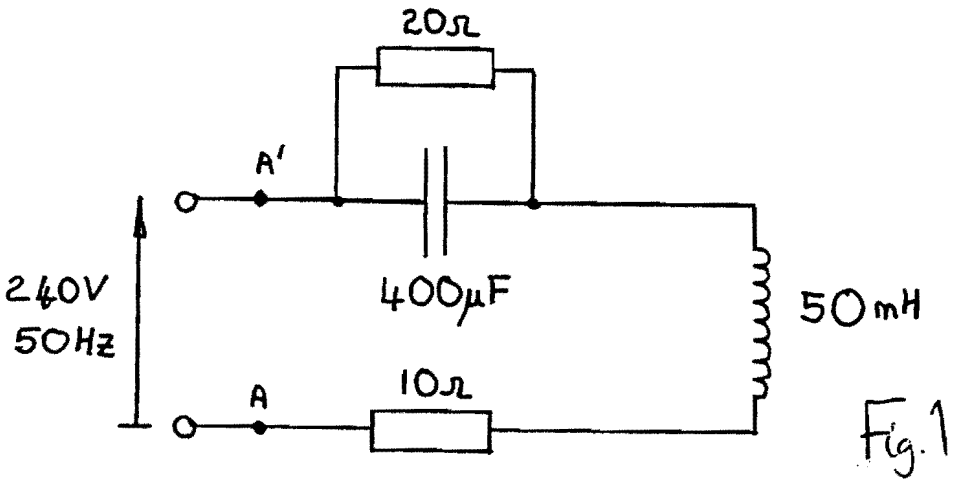

Fig. 1

For the circuit shown in Fig. 1, calculate:

(i) the input impedance;
(ii) the supply current;
(iii) the input power;
(iv) the input VARs;
(v) the power factor;
(vi) the power dissipated in the 20 Ω resistance;
(vii) the VARs generated by the capacitor.

2. The power factor of the above circuit is to be corrected to unity by connecting a capacitor between A and A'. What value capacitor should be used ?

Which of the quantities (i) - (vii) in Q.1 change, and what will their new values be ?

Three-Phase Systems

† 3. A three-phase supply of 11 kV (line) feeds a delta-connected balanced three-phase load. Each leg of the delta has an impedance of 205 + j96 ohm.

Calculate:

(i) the line current;
(ii) the input power;
(iii) the input VARs;
(iv) the power factor.

The load is now reconnected into star. What values will the quantities (i) - (iv) now have ?

† 4. An 11 kV three-phase power line feeds two isolated factories, which are effectively connected in parallel with each other. The first factory load is star-connected, and it draws 6 MW at a power factor of 0.8 leading. The second factory is delta-connected and it draws 8 MW at a power factor of 0.6 lagging. Calculate the supply line current and power factor. Determine also the phase voltage and current for the two factory loads.

5. A town takes a load of 60 MW at a power factor of 0.85 lagging as a balanced load from a three-phase feeder power line. The line voltage at the town is 132 kV, and the feeder has an impedance of 10 + j55 Ω per line. Find the line current, and calculate the line voltage at the sending end of the feeder.

What would be the reduction in power loss in the feeder if the power factor of the load were improved to unity while the load voltage remained at 132 kV, and what would the sending-end line voltage then be ?

* 6. A 415 V, 50 Hz, 3-phase supply feeds a star-connected load consisting of three impedances of (10+ j10) ohms, and a delta-connected load consisting of three impedances of (30+j10) ohms. Calculate the line current taken from the supply, and the total power dissipated in the loads.

What value of three identical capacitors connected in star, is required to change the power factor to 0.95 lagging ?

ANSWERS

1. (i) 12.73 + j8.83 Ω (ii) 15.49 A
   (iii) 3054 W (iv) 2119 VAR
   (v) 0.822 lag (vi) 655 W
   (vii) 1650 VAR

2. 117 μF
   (i) 18.86 + j0 Ω (ii) 12.73 A
   (iii) No change (iv) 0
   (v) 1.0 (vi) & (vii) No change

3. In delta (i) 84.2 A (ii) 1452 kW
   (iii) 680 kVAR (iv) 0.906 lag
   In star (i) 28.0 A (ii) 484 kW
   (iii) 227 kVAR (iv) 0.906 lag

4. 803 A, 0.915 lag, Star: 6.35 kV, 394 A
   Delta: 11 kV, 404 A

5. 308.7 A, 153.7 kV, 793 kW, 138.8 kV

6. 38.6 A, 24.1 kW, 108.7 μF

Tripos Questions (Paper 5)

Year	**Paper 5/3**	**Paper 5/4**	**Paper 5/5**
2002	3	4	
2003	3	4 (pu)	5
2004	3	4	5
2005	5	3	4
2006	3	4	5
2007	3,4		5
2008	4	3	5
2009	3	4	5

T A Coombs

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