6. a. Describe with the aid of a diagram how torque is developed in a three-phase induction motor. **(4 marks)**

b. The input to a 4 pole, 3 phase, 50 Hz induction motor is 40 kW at a speed of 1450 revs / min. The stator losses are 1.2 kW and the friction and windage losses are 1.8 kW: Find:

i. The Slip. **(3 marks)**
ii. The rotor copper losses **(3 marks)**
iii. The output power **(3 marks)**
iv. The efficiency of the motor, neglecting the rotor iron loss. **(3 marks)**

c. Explain how the power factor (p.f.) of such a motor may be improved. **(4 marks)**

END OF PAPER

EXAMINATION FOR THE ISSUE OF A LICENCE TO ACT AS WIREMAN - LICENCE 'B'

JULY 2016

Paper I (Theory)

Time Allowed: 3 Hrs

WRITE ALL YOUR WORK IN THE ANSWER BOOK PROVIDED
EVERY ANSWER SHOULD INCLUDE ALL WORKINGS, NECESSARY DIAGRAMS AND FORMULAE.

START EACH ANSWER ON A FRESH PAGE.

Answer any **FIVE** Questions

1. A short shunt compound generator supplies 100A at 110 Volts. The armature resistance is 0.05 ohm. The shunt field resistance is 57 ohms and the series field resistance is 0.04 ohm. Iron and friction losses amount to 852 Watts.

   Find:
   a. The E.M.F. generated. **(7 marks)**
   b. The copper losses in:
      i. the armature. **(2 marks)**
      ii. the series field. **(2 marks)**
      iii. the shunt field. **(2 marks)**

   c. The overall efficiency. **(7 marks)**

2. a. Define power factor and explain why it should be kept as high as economically possible in an electrical installation. **(5 marks)**

   b. A transformer supplies a load of 360 KW at 0.6 p.f. lagging. Calculate:

      i. The KVAr rating of the loss-free static capacitors required to correct the p.f. to 0.95 lagging. **(5 marks)**
      ii. The KW input to a synchronous motor required to correct the p.f. from 0.6 lagging to 0.95 lagging. **(5 marks)**
      iii. Illustrate your answers with suitable phasor diagrams. **(5 marks)**

3. a. The input power to a Delta connected three-phase 400V 50Hz induction motor was measured by the Two Watt-meter method. The instrument readings were 30kW and -15kW respectively. Draw a clearly illustrated diagram showing how the motor and the Watt-meters are connected for the test. **(4 marks)**

   b. Calculate:

      i. The total power in kW taken by the motor. **(2 marks)**
      ii. The power factor (p.f.) of the motor. **(4 marks)**
      iii. The Apparent power (kVA) of the circuit **(2 marks)**
      iv. The Line current **(3 marks)**
      v. The phase current **(2 marks)**

   c. One of the watt-meters is reading negatively. What does this indicate? **(3 marks)**

4. **Refer to Figure 1:**

   Refer to the circuit diagram below which shows a coil of inductance 165.52 mH and a resistance 25Ω connected in parallel with a 33μF capacitor, across a 230V, 50 Hz supply. Sketch the circuit and phasor diagrams and calculate:
   a. The current through and phase angle of the coil. **(6 marks)**
   b. The capacitor current. **(5 marks)**
   c. The supply current and phase angle. **(5 marks)**
   d. The power consumed and **(2 marks)**
   e. The circuit impedance. **(2 marks)**

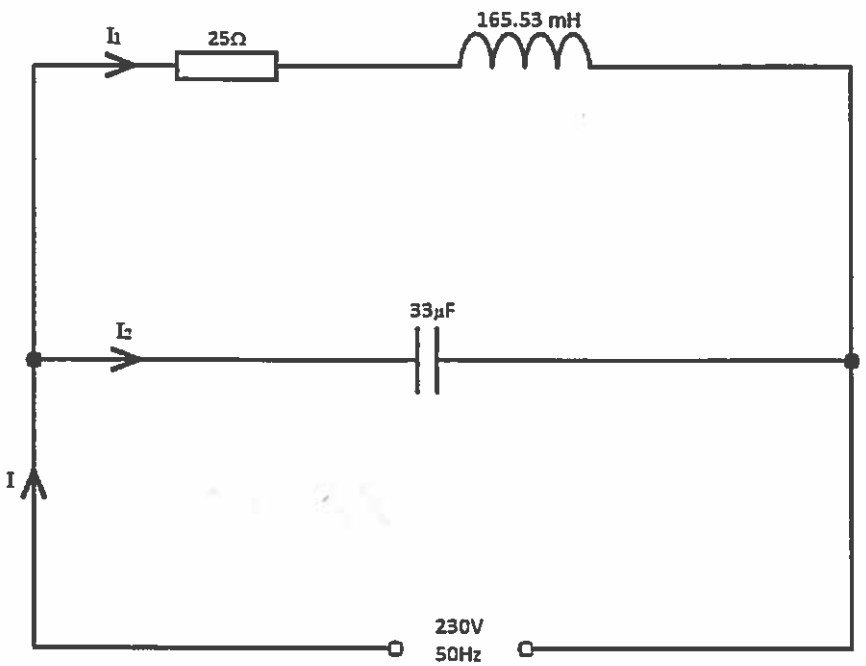

Figure 1

5. a. Explain what is meant by the temperature coefficient of resistance of a material. **(4 marks)**

   b. A platinum resistance thermometer has a resistance $R_0 = 50.0\ \Omega$ at T_0=20 °C. The temperature coefficient of resistance (α) for platinum is $3.92\times10^{-3}\ (°C)^{-1}$. The thermometer is immersed in a vessel containing melting tin, at which point R increases to 91.6Ω. Calculate the melting point of tin? **(6 marks)**

   c. Consider a typical tungsten filament at a temperature 20° C and which is 1m long with a radius of 0.05mm. Assume resistivity of tungsten $\rho = 5.6\times10^{-8}\ \Omega m$. Note: the resistivity value used above is valid only at a temperature of 20°C, so this derived value of resistance (R) holds only for T = 20°C. Calculate the resistance value. **(4 marks)**

   d. The resistance of a coil of aluminium wire at 18° C is 205 Ω. The temperature of the wire is increased and the resistance rises to 245 Ω. If the temperature coefficient of resistance of aluminium is 0.0039/° C at18° C, determine the temperature to which the coil has risen. **(6 marks)**