5. (a) i. Mention two types of construction used for induction motors and state which is the least expensive to manufacture. **(3 marks)**

ii. State the losses in an induction motor. **(2 marks)**

iii. Define synchronous speed and slip. **(4 marks)**

iv. Sketch a typical torque/slip characteristic. **(3 marks)**

(b) The power supplied to a three-phase induction motor is 40kW and the corresponding stator losses are 1.5kW. Calculate:

i. The total mechanical power developed and the rotor $I^2R$ loss when the slip is 4%. **(4 marks)**

ii. The output power of the motor if the friction and windage losses are 0.8kW **(2 marks)**

iii. The efficiency of the motor, neglecting the rotor iron loss. **(2 marks)**

6. (a) A Short circuit and an Open circuit test is performed on a single phase transformer. With the aid of diagram explain each test, stating clearly the losses measured in each test. **(10 marks)**

(b) An Open circuit test is carried out on a 50kVA, 1200/230V single phase transformer. While performing the Open circuit test the watt meter connected to the transformer was reading 550 watt. A Short circuit test was also carried out on the transformer. From the Short circuit test it resulted that the effective resistance of the secondary winding was found to be 0.018Ω.

Find the Total loss in KW and the efficiency of the transformer when it is delivering Full Load Power at 0.8 power factor (p.f.) lagging. **(10 marks)**

**END OF PAPER**



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

## February 2015

## 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. Refer to Figure 1:

Refer to the circuit diagram below which shows a pure inductance of 100mH which is connected in parallel with a 20μF capacitor and supplied from a 120V, 50Hz supply. Determine

(a) The branch currents, **(5 marks)**
(b) The supply current and its phase angle, **(2 marks)**
(c) The circuit impedance and **(2 marks)**
(d) The power consumed. **(1 marks)**
(e) Repeat for the above for the condition when the frequency is changed to 150 Hz. **(10 marks)**

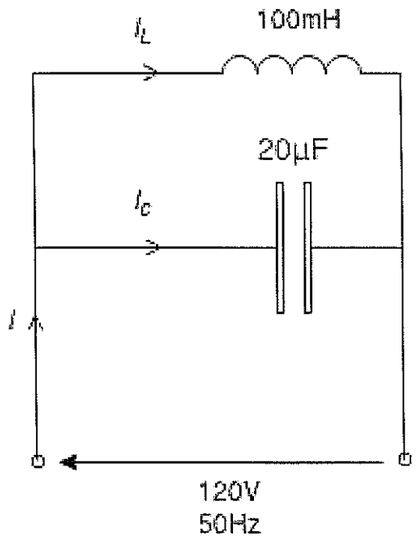


**Figure 1**

2. (a) State Kirchhoff 's laws as applied to an electrical circuit. **(5 marks)**
(b) A two wire phase neutral ring main circuit ABC is supplied at 230V at point A and has loads of 40Amp and 120Amp at points B and C respectively. The resistance for EACH conductor per section is as follows:

- Between AB 0.016Ω,
- Between BC 0.02Ω,
- Between CA 0.02Ω.

Using Kirchhoff 's laws, find the voltage
i) At point B **(6 marks)**
ii) At point C **(6 marks)**

(c) What are the advantages of a ring main circuit? **(3 marks)**



3. (a) i. Define power factor of an AC electrical power system. **(3 marks)**
ii. Explain the disadvantages of having a low overall power factor in a large distribution network. **(2 marks)**
iii. Describe why power factor improvement could result in a reduction of the energy cost of an industrial consumer. **(2 marks)**

(b) A factory is supplied from a 3-phase, 400V, 50Hz source. The overall load is 600kW and 350kVAr lagging. The load is balanced.
i. Draw a phasor diagram and calculate the power factor of the load. **(2 marks)**
ii. Calculate the reactive power needed to improve the power factor to 0.92. Sketch the resulting phasor diagram. **(3 marks)**
iii. Calculate the capacitance per phase connected in star needed for this power factor improvement. **(3 marks)**
iv. Calculate the reduction in current and apparent power taken from the source after power factor correction is implemented. **(3 marks)**

(c) If the power factor is said to be leading, what electrical equipment can be used to correct it? **(2 marks)**

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

**Refer to Table 1 below:**

(b) Explain the meaning of the negative sign shown for the temperature coefficient of resistance for carbon and give an application where carbon is used in motors. **(4 marks)**

(c) Choose the temperature coefficient of resistance of a material commonly used for the **winding** (conductor) of a DC shunt motor. Give two advantages of the chosen material. **(2 marks)**

(d) A tower crane hoist DC shunt motor is controlled by an electronic DC drive system. The information shown on the nameplate of the hoist DC shunt motor winding is 50Ω at 20°C. After lifting several heavy loads, smoke was seen coming out from the hoist DC motor. Having carried out an inspection and testing, the resistance of the shunt winding of the hoist DC motor was found to be 70Ω.

Find the temperature of the shunt winding of the hoist DC motor using the temperature coefficient of resistance chosen in your answer of 4(c) above. **(10 marks)**

| Type of Material | Temperature Coefficient of resistance 0° C |
|---|---|
| Eureka | 0.00001/°C |
| Aluminium | 0.0038/°C |
| Copper | 0.004/°C |
| Carbon | -0.00048/°C |

Table 1