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

July 2014

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) A factory has a total load of 252 Amp per phase at an operating power factor of 0.7 lagging. The 3-phase supply voltage is 400V 50 Hz.

Calculate:

i) The real and reactive power. **(2marks)**

ii) The capacitance per phase of a capacitor bank connected in STAR to improve the operating power factor to 0.95 lagging. **(4 marks)**

b) The factory load is assumed to be constant for the following working hours; 8 hours per day, 5 days per week for 52 weeks per year.
Calculate, using the bands for Non-Residential kVAh tariff, the energy cost for:

i) Option 1 – **without** power factor correction. **(5 marks)**

ii) Option 2 – **with** power factor correction. **(5 marks)**

Tariff bands and service charge are given in ***Table 1.1***.

c) Calculate:

i) The cost savings per year when a power factor correction is installed. **(2 marks)**

ii) The payback period for the capacitor bank if the cost per kVAr is €31.25. **(2 marks)**

Table 1.1

Non residential service charges		
Service Charge	**Charge**	
Single Phase	€ 120	
Three Phase	€ 360	
Non residential kVAh charges		
Band	**Cumulative Consumption**	**Tariff (€)**
1	0 - 2,000	0.149
2	2,001 - 6,000	0.156
3	6,001 - 10,000	0.168
4	10,001 - 20,000	0.182
5	20,001 - 60,000	0.198
6	60,001 - 100,000	0.184
7	100,001 - 1,000,000	0.172
8	1,000,001 - 5,000,000	0.156
9	5,000,000 & over	0.132

2 a) Describe the following losses for an induction motor:

i) Stator losses **(3 marks)**

ii) Rotor copper losses **(3marks)**

b) The power input to the stator of a 8-pole, 50Hz cage induction motor is 60kW when it is operating at a slip of 4.5%. The stator losses are 1250W and the friction, winding and iron losses are 700W.

Determine:

i) The motor speed in revs/min **(3 marks)**

ii) The rotor copper losses **(3 marks)**

iii) The shaft power output **(3 marks)**

iv) The output torque **(3 marks)**

v) The overall efficiency of the motor **(2 marks)**

3 a)

i) Draw a circuit diagram for a single-phase 230V, 50Hz a.c. full-wave rectification using four (4) rectifier diodes and a double wound transformer. **(9 marks)**

ii) For the diagram drawn above in 3 (a) (i) show also the current flow for **one** half-cycle from the secondary winding of the transformer. **(3 marks)**

iii) Draw the symbol of a diode and clearly label the cathode and anode. **(2 marks)**

iv) With the aid of diagram(s) explain how to test a diode using a multimeter on the resistance range. **(3 marks)**

b) For the above full-wave rectified d.c. voltage show how smoothing is obtained and explain briefly how it is achieved. **(3 marks)**

4. A twin-core cable runs from a substation where the voltage is maintained constant at 240 volts.

The resistance of each core of the cable is 0.1ohm per 1000m.

At a distance of 400 metres from the substation there is a load of 40 amperes and at a distance of 700 metres there is a load of 60 amperes.

a) Draw a diagram showing all the layout of the loads. **(2 marks)**

b) Find the power consumption of each load. **(6 marks)**

c) The power wasted in the cable. **(6 marks)**

d) The total power supplied by the substation. **(6 marks)**

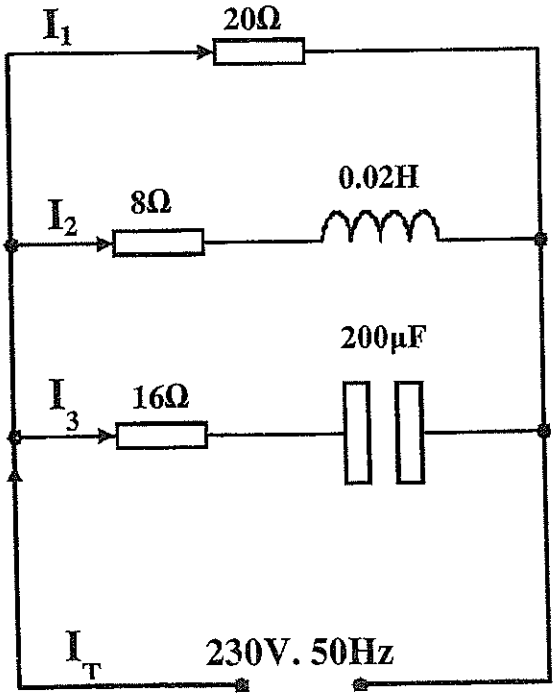
5. A short shunt compound generator supplies a load at 100 volts through a pair of feeders of total resistance 0.05 ohms. The load consists of four motors each taking 40 amperes and a lighting load of 200, 60 Watts lamps.
The armature resistance, is 0.02 ohms
The series field, is 0.05 ohms
Shunt field resistance, is 50 ohms

Find:

a) Load current. **(6 marks)**
b) Terminal voltage. **(6 marks)**
c) EMF generated. **(6 marks)**
d) Draw the circuit diagram. **(2 marks)**

6. Refer to the circuit diagram below which shows 20Ω resistor connected in parallel with two separate series circuits. One circuit consists of 8Ω resistor in series with an inductor of 0.02H and the other circuit consists of 16Ω in series with a 200 microfarad capacitor. The circuit combination is connected across a 230V, 50Hz supply. Calculate:

a) The current flowing in each branch. **(6 marks)**
b) The total (resultant) current flowing from the 230V supply. **(5 marks)**
c) The power factor of the circuit combination. **(2 marks)**
d) The power dissipated by the circuit combination. **(3 marks)**
e) Draw a graphical representation or phasor diagram. **(4 marks)**



END OF PAPER