DEPARTMENT OF EXAMINATIONS
THE MALL, SARRIA STREET, FLORIANA, MALTA

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**Examination for Authorisation B**

**Paper 1:** **Theory**

**Date:** **July 2021**

**Time:** **09:00 – 12:00 (Three hours)**



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**This examination paper contains six questions. Candidates are requested to answer any FIVE (5) questions. Candidates are also requested to include all their work in the booklet provided. Every answer should include all workings, any necessary diagrams and formulae. Use a fresh page for each different question. Each question carries 20 marks.**

1. i. Write down the formula for finding the total torque of a d.c. motor. **(2 marks)**

   ii. Briefly explain each part of the formula and give the unit of each item. **(3 marks)**

   iii. A d.c. motor develops a total torque of 150 Nm when its armature current is 25A and the useful flux per pole is 0.25 Wb. Calculate the total torque when the armature current increases to 35A and the flux is reduced to 0.2 Wb. **(15 marks)**

2. The maximum flux density in the core of a 240 volts / 3000volts, 50 Hz transformer is 1.25 Wb/m2. If the e.m.f induced per turn is 9 volts.
   Answer the following:

   i. Write and explain the E.M.F. Equation of the transformer. **(2 marks)**

   ii. Find the number of primary turns. **(6 marks)**

   iii. Find he number of secondary turns. **(6 marks)**

   iv. Find the area of the core. **(6 marks)**

3. A coil of resistance 60Ω and inductance 318.4mH is connected in parallel with a 15μF capacitor across a 200V, 50Hz supply.
   Calculate:

   i. the current in the coil **(2 marks)**

   ii. the current in the capacitor **(2 marks)**

   iii. the supply current and its phase angle **(4 marks)**

   iv. the circuit impedance **(3 marks)**

   v. the power consumed **(3 marks)**

   vi. the apparent power **(2 marks)**

   vii. the reactive power **(2 marks)**

   viii. sketch a phasor diagram. **(2 marks)**



4. (a) Three 230V single-phase loads are supplied from a 400V, 50Hz, 3 phase 4-wire system. The loads are connected as follows:

   - 10kW at unity power factor connected between L1 and N
   - 15kVA at 0.8 power factor lagging connected between L2 and N
   - 8kVA at 0.7 power factor lagging connected between L3 and N

   (b) Calculate:

   i. The current in each line conductor **(6 marks)**
   ii. The current in the neutral **(10 marks)**
   iii. Draw a neat and detailed phasor diagram. **(4 marks)**

5. (a) Explain what is meant by **slip** in an induction motor. **(2 marks)**

   (b) A 380V, three phase, 50Hz, two pole, star connected induction motor operates at 2880 rev/min on full load. The rotor resistance and reactance per phase are 0.35Ω and 3.5Ω respectively and the effective rotor-stator turns ratio is 0.8:1.
   Calculate:

   i. the synchronous speed **(2 marks)**
   ii. the slip **(2 marks)**
   iii. the rotor current at full load **(4 marks)**
   iv. the torque at full load **(5 marks)**
   v. the torque at start. **(5 marks)**

6. (a) Explain with the aid of diagrams how to measure the power of a three phase **STAR** connected load as follows:

   i. the three-phase load is balanced. **(2 marks)**
   ii. If the load is unbalanced, how do you measure the power? **(2 marks)**
   iii. How do you measure the power using two wattmeters? **(3 marks)**
   iv. What are the advantages of using the two wattmeter method over the one wattmeter method? **(3 marks)**

   (b) The power supplied to a three-phase induction motor is 75 kW and the stator losses are 2.5 kW. If the slip is 4%, determine the following:

   i. The rotor coper loss **(3 marks)**
   ii. The mechanical power developed by the rotor **(2 marks)**
   iii. The output power of the motor if friction and windage losses are 1.2 kW, and **(2 marks)**
   iv. The efficiency of the motor, neglecting rotor iron losses. **(3 marks)**

**END OF EXAMINATION PAPER**