



6. A substation S feeds a direct current distributor at 235 volts.

Consumer X which is 200m from the substation takes 120 amps.

Consumer Y which is 450m from the substation takes 80 amps.

Consumer Z which is 600m from the substation takes 100 amps.

The feeder cable has a resistance of 0.08 ohms per 1000m per core.

- a. Draw a neat and well-labelled circuit diagram (2 marks)
- b. i. Calculate the voltage at consumer X. (6 marks)  
ii. Calculate the voltage at consumer Y. (6 marks)  
iii. Calculate the voltage at consumer Z. (6 marks)

**Total: 100 marks**

**END OF EXAMINATION PAPER**

## Examination for Authorisation B

Paper 1: Theory

Date: 3 July 2019

Time: 09:00 – 12:00 (Three hours)

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. Three loads are connected across a 380 volts 50 Hz supply. The loads are described as follows:

- Load A: 3-phase 12kW motor operating at 0.8 lagging power factor
- Load B: a balanced 20kVA 3-phase transformer operating at a lagging angle of  $60^\circ$ .
- Load C: 6kW balanced load of heaters operating at unity power factor.

- (a) For each load give the values of real, apparent and reactive power. (6 marks)
- (b) Draw a power triangle for each load. (3 marks)
- (c) Calculate the total real power connected across the supply. (2 marks)
- (d) What is the overall power factor of the system? (4 marks)
- (e) Calculate the total current drawn from supply. (5 marks)

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

(b) A 380 volt, 3-phase, 50Hz, two pole, star connected induction motor operates at 2880 rev/min on full load. The rotor resistance and reactance per phase are 0.35 ohms and 3.5 ohms 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)

- (a) What is meant by the term **back e.m.f.** when related to DC motors? (3 marks)
- (b) Draw the torque / armature current and speed / armature current relationship for a series motor and a shunt motor. (4 marks)
- (c) On full load a 330 volt series motor takes 90 amps and runs at 15 rev/s. The armature resistance is 0.1 ohm and the series winding resistance is 50 milli ohms. Determine the speed when developing full load torque with a 0.2 ohm diverter in parallel with the field winding (assume that the flux is proportional to the field current). (13 marks)

4. A coil has inductance 0.318 Henries and resistance 200 ohms. A capacitor of value 3.18 micro Farad is connected in parallel with the coil to a sinusoidal supply of variable frequency.

- (a) Draw a neat and well-labelled circuit diagram. (3 marks)
- (b) Draw the phasor diagram. (3 marks)
- (c) Calculate the frequency at which the supply current and voltage are in phase. (14 marks)

5. (a) State the advantages and the disadvantages of an auto transformer when compared to a double wound transformer. (6 marks)

(b) A 3-phase transformer has 500 primary turns and 50 secondary turns. If the primary is connected to a supply voltage of 2400 volts, find the secondary line voltage on no load when the windings are connected

- **Star – Delta** (7 marks)
- **Delta – Star** (7 marks)