

BINDURA UNIVERSITY OF SCIENCE EDUCATION
FACULTY OF SCIENCE AND ENGINEERING

AEH 508

Department Of Engineering and Physics
Bachelor of Science (Honours) in Agricultural Engineering
Electrification for Agriculture

3 HOURS (100 MARKS)

- JUN 2023

INSTRUCTIONS

Answer any **FOUR** questions. Each question carries 25 marks.

Question 1

- a. Highlight two merits of automating a substation. [2 marks]
- b. Distinguish the radial distribution system from the ring-main distributor system of electricity. [8 marks]
- c. A d.c. 2-wire distribution system is converted into an a.c. 3-phase, 3-wire system by adding a third conductor of the same size as the two existing conductors. If voltage between conductors and percentage power loss remain the same, calculate the percentage additional balanced load which can now be carried by the conductors at 0.95 p.f. [15 marks]

Question 2

- a. Explain the term 'string efficiency', suggesting two ways to improve it. [5 marks]
- b. With the aid of a well labelled diagram, describe the composition of a 3-core extra-high-tension armoured cable. [8 marks]
- c. A transmission line has a span of 150 metres between supports, the supports being at the same level. The conductor has a cross-sectional area of 2 cm^2 , an ultimate strength of 5000 kg/cm^2 and a specific gravity of 8.9. If the wind pressure is 1.5 kg/m length of the conductor, calculate the sag at the centre of the conductor if factor of safety is 5. [12 marks]

Question 3

- a. Briefly describe two advantages of using electric motors in a 'group drive' system. [4 marks]
- b. Briefly explain five ills that contribute to constraints and clumsy present day power distribution network. [10 marks]
- c. Describe the functions of the following units that make up the Supervisory Control And Data Acquisition (SCADA) system in the electric utility:
 - i. Sectionalizing Switches, [3 marks]
 - ii. Data Acquisition System (DAS), [3 marks]
 - iii. Remote Terminal Unit (RTU). [5 marks]

Question 4

- a. Suggest five positive factors that can be achieved by using electric motor 'individual drive' systems. [5 marks]
- b. Explain why ball bearings are the most preferred type over other bearings in the production of electric motors upto 75 kW. [5 marks]

- c. Highlight four merits of and two demerits for *electric drive* systems over *mechanical drive* systems. [6 marks]
- d. A football pitch $120\text{ m} \times 60\text{ m}$ is to be illuminated for night play by similar banks of equal 1000 W lamps supported on twelve towers which are distributed around the ground to provide approximately uniform illumination of the pitch. Assuming that 40% of the total light emitted reaches the playing pitch and that an illumination of 1000 lm/m^2 is necessary for television purposes, calculate the number of lamps on each tower. It is given that the overall efficiency of the lamp is to be taken as 30 lm/W . [9 marks]

Question 5

- a. Describe the protection of buildings against the dangers of lightning. [8 marks]
- b. If a 250-V , d.c. shunt motor, with armature resistance $R_a = 0.09\ \Omega$, full-load $I_a = 150\text{ A}$, full-load speed of 550 rpm , is braked by reversing the connections to the armature and inserting additional resistance in series with it, calculate:
- the value of resistance that must be placed in series with the armature circuit to limit the initial braking current to 240 A , [5 marks]
 - the initial value of braking torque and [6 marks]
 - the torque when motor speed falls to 200 rpm . [6 marks]

Question 6

- a. With the aid of named examples, describe the following types of lighting schemes:
- Direct lighting, [3 marks]
 - Indirect lighting. [4 marks]
- b. A drawing office containing a number of boards and having a total effective area of 70 m^2 is lit by a number of 40 W incandescent lamps giving 11 lm/W . An illumination of 80 lux is required on the drawing boards. Assuming that 60% of the total light emitted by the lamps is available for illuminating the drawing boards, estimate the number of lamps required. [8 marks]
- c. If a 21 cm diameter globe of dense opal glass encloses a lamp emitting 1000 lumens with a uniform brightness of $4 \times 10^3\text{ lumen/m}^2$ when viewed in any direction, calculate:
- the luminous intensity of the globe in any direction, [7 marks]
 - percentage of the flux emitted by the lamp that is absorbed by the globe. [3 marks]

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