WORKFORCE DEVELOPMENT AUTHORITY
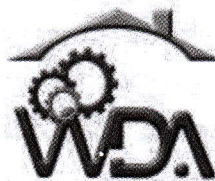
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ADVANCED LEVEL NATIONAL EXAMINATIONS, 2015, TECHNICAL AND PROFESSIONAL TRADES

EXAM TITLE: Electrotechnics

OPTION: Electricity (ELC)

DURATION: 3hours

INSTRUCTIONS:

The paper is composed of **three (3) Sections**:

Section **I**: Fourteen **(14)** questions, all **Compulsory**.   **55marks**

Section **II**: Five (5) questions, **Choose Three (3) only.**   **30marks**

Section **III**: Three (3) questions, **Choose only One (1).**   **15marks**

Every candidate is requested to strictly obey the above instructions. Punishment measures will be applied to anyone who ignores these instructions.

Section I. Fourteen (14) Compulsory questions.   55marks

01. Calculate the resistance of electric wire in aluminum of 1km length and 2.4mm diameter knowing that $\delta=2.6 \times 10^{-8}$ Ωm.   **4marks**

02. A copper conductor has a cross section of 2mm². Calculate its length if the resistance of conductor is 2Ω and $\delta=1.6 \times 10^{-8}$ Ωm.   **4marks**

03. State the Kirchhoff's current law.   **4marks**

04. State the Ohm's law.   **4marks**

05. A copper coil has a resistance of 80Ω at a temperature of 20°C. What is the value of temperature of the same coil, if the measurement gives a resistance of 96.72 Ω. Take $\alpha_{20°}=0.0038/$°C.   **5marks**

06. Define:

a) RMS   b) DC   c) AC   d) Hz   **2marks**

07. Define the ground fault circuit interrupter and its usage.   **3marks**

08. State the Faraday's law.   **3marks**

09. Define:

a) A Generator   b) A Motor   **4marks**

10. a) Define the nameplate of the electrical machine.

b) State any three typical information conveyed by the nameplate of the electrical machine.   **5marks**

11. Describe the Right-hand rule using a drawing.   **5marks**

12. Define the electrical circuit and with net sketch, give types of the electrical circuit.   **5marks**

13. Find the total resistance of the circuit below: **3marks**
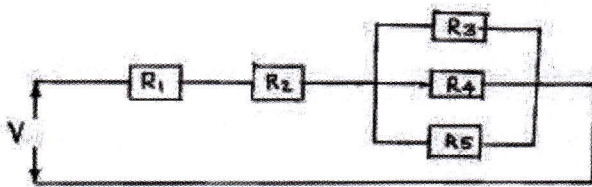
14. With drawing, define a solenoid.   **4marks**

Section II. Answer any three (3) questions of your choice
(Do not choose more than <u>three questions</u>).   30marks

15. An iron ring has a cross-section of 3 cm² and a mean diameter of 25 cm. An air-gap of 0.4 mm has been cut across the section of the ring. The ring is wound with a coil of 200 turns through which a current of 2 A is passed. If the total magnetic flux is 0.24 mWb, find the relative permeability of iron, assuming no magnetic leakage.   **10marks**

16. A 220 V d.c series motor has armature and field resistances of 0.15 Ω and 0.10 Ω respectively. It takes a current of 30 A from the supply while running at 1000 rpm. If an external resistance of 1 Ω is inserted in series with the motor, calculate the new steady state armature current and the speed. Assume the load torque remains constant.

10marks

17. a) Draw a diagram showing the power stages for a DC generator.

b) What is "Armature reaction" and what are its effects?

c) A 4-pole generator has a wave-wound armature with 722 conductors, and it delivers 100A on full load. If the brush lead is 8°, calculate the armature demagnetising and cross-magnetising ampere turns per pole.

10marks

18. A 3-phase, 50-Hz transformer has a delta-connected primary and star-connected secondary, the line voltages being 22,000 V and 400 V respectively. The secondary has a star connected balanced load at 0.8 power factor lagging. The line current on the primary side is 5 A.

Determine:

a) The current in each coil of the primary,

b) The current in each secondary line,

c) What is the output of the transformer in kW?

10marks

19. The power input to the rotor of 440 V, 50 Hz, 6-pole, 3-phase, and induction motor is 80 kW. The rotor electromotive force is observed to make 100 complete alterations per minute. Calculate

a) The slip,

b) The rotor speed,

c) Rotor copper losses per phase.

10marks

Section III. Answer any one (1) question of your choice
(Do not choose more than <u>one question</u>).   **15marks**

20. a) Find the efficiency of a 10kVA, 1000/200V single phase transformer supplying a full load at 0.8 p.f lagging. Its total resistance transferred to secondary is 0.1Ω and its no load current measured on the H.V side is 2A at 0.3 p.f lagging.

b) Water for a hydro-electric station is obtained from a reservoir with a head of 100 metres. Calculate the electrical energy generated per hour per cubic metre of water if the hydraulic efficiency is 0·86 and electrical efficiency is 0·92.

15marks

21. A 40 kW, 8poles induction machine is connected to 414V, 3 phase, 50Hz supply. When working as motor on full load its efficiency is 0.85, its power factor is 0.8 lagging and its slip is 0.03When working as generator at slip of 0.04, its power factor is 0.78 leading and its efficiency is 0.82. Find for each mode of operation the:

i)   Rotor speed in rev/min

ii)   Rotor frequency

iii)   Torque at the shaft

iv)   Line and phase currents assuming the stator to be connected in delta

15marks

22. a) A section through a magnetic circuit of uniform cross-sectional area 2 cm² is shown in Figure below (a). The cast steel core has a mean length of 25 cm. The air gap is 1mm wide and then coil has 5000 turns. The B–H curve for cast steel is shown below. Determine the current in the coil to produce a flux density of 0.80T in the air gap, assuming that all the flux passes through both parts of the magnetic circuit.

8marks
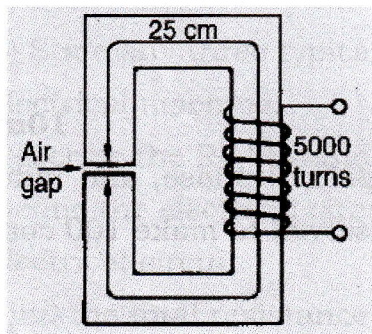
Magnetic circuit (a)
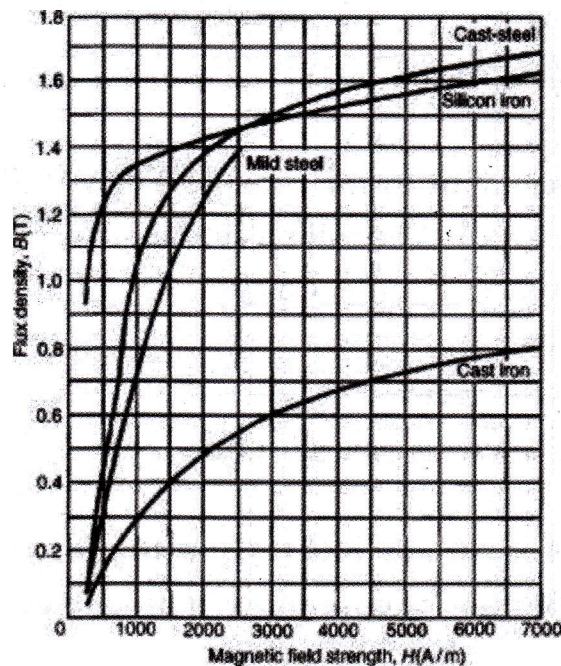
B–H curve

b) What is the maximum length in km for a 1-phase transmission line having copper conductor of 0·775 cm2 cross-section over which 200 kW at unity power factor and at 3300V are to be delivered? The efficiency of transmission is 90%. Take specific resistance as 1.725 μ Ωcm.

7marks