ELC - Electrotechnics

T001

Thursday, 10/11/2016

08:30 – 11:30

WORKFORCE DEVELOPMENT AUTHORITY

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ADVANCED LEVEL NATIONAL EXAMINATIONS, 2016, TECHNICAL AND PROFESSIONAL STUDIES

EXAM TITLE: **Electrotechnics**

OPTION: **Electricity (ELC)**

DURATION: **3hours**

INSTRUCTIONS:

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

Section I: Seventeen (17) compulsory questions.	**55 marks**
Section II: Attempt **any three (3)** out of five questions.	**30 marks**
Section III: Attempt **any one (1)** out of three questions.	**15 marks**

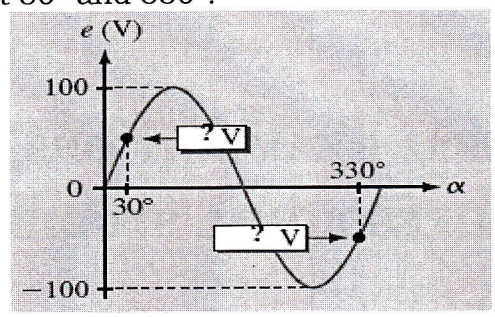
Note:

Every candidate is required to carefully comply with the above instructions. Penalty measures will be applied on their strict consideration

01. What are the instruments used for measuring the following electrical quantities?
a) Power
b) Resistance **2marks**

02. What is "Dielectric"? **2marks**

03. If the amplitude of the waveform of Figure below is E_m= 100 V, determine the voltage at 30° and 330°.



2marks

04. The conductors of the stator of a generator have a length of 0.5m. The conductors move through a magnetic field of 0.8 teslas at a speed of 68 m/s. Find, the amount of induced voltage in each conductor. **2marks**

05. What are the factors on which the resistance of a material depends? **4marks**

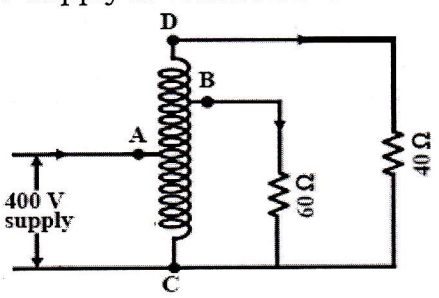
06. A single phase transformer has 500 turns on its primary and 1000 turns on its secondary.
a. Determine its turns ratio. Is it step-up or step-down?
b. If its primary voltage is e_p= 25 sin ωtV, what is its secondary voltage?
c. Sketch the waveforms. **5marks**

07. Write down the expression for reluctance. What is its unit? **2marks**

08. A 12-pole, 3-phase alternator driven at a speed of 500 r.p.m. supplies power to an 8-pole, 3-phase induction motor. If the slip of the motor, at full-load is 3%, calculate the full-load speed of the motor. **4marks**

09. Write down the conditions for production of steady electromagnetic torque for a rotating electrical motor. **3marks**

10. An autotransformer has a coil with total number of turns N_{CD}= 200 between terminals **C** and **D**. It has got one tapping at **A** such that the number of turns N_{AC}= 100 and another tapping at **B** such that the number of turns N_{BA}= 50. As shown in figure below. Calculate current and voltage for each resistance of the circuit, when 400 V supply is connected across AC.



4marks

11. Calculate the distribution factor for a 36-slots, 4-pole, single-layer three-phase winding. **2marks**

12. A parallel-plate capacitor with air dielectric has a value of $C = 12$ pF. What is the capacitance of a capacitor that has the following:

a. The same separation and dielectric but five times the plate area?

b. The same dielectric but four times the area and one-fifth the plate spacing?

4marks

13. What do you understand by the **'back e.m.f.'**? **1mark**

14. A d.c. motor connected to a 460-V supply has an armature resistance of 0.15 Ω. Calculate:

1) The value of back e.m.f. when the armature current is 120 A. **2marks**

2) The value of armature current when the back e.m.f. is 447.4 V. **2marks**

15. The maximum flux density in the core of a 250/3000-volts, 50-Hz single-phase transformer is 1.2 Wb/m^2. If the e.m.f. per turn is 8 volt, determine:

a) the primary and secondary turns and

b) the area of the core. **4marks**

16. A single-phase transformer has 400 primary and 1000 secondary turns. The net cross-sectional area of the core is 60 cm^2. If the primary winding be connected to a 50-Hz supply at 520 V, calculate:

A) the maximum value of flux density in the core. **2marks**

B) the voltage induced in the secondary winding. **2marks**

17. A DC motor, when connected to a 100V source and to no load runs at 1200rpm. Its stator resistance is 2Ω. What should be the torque and current if it is fed from a 220V supply and its speed is 1500rpm? Assume that the field is constant.

6marks

Section II. Choose and answer any three (3) questions. **30marks**

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18. Three lamps A, B and C, having resistances of 1440Ω, 960Ω and 576, are connected in parallel to a 240 V supply by a cable of resistance 2Ω. Calculate (a) the total circuit resistance, (b) the total current, (c) the cable voltage drop, (d) the voltage across the lamps and (e) the current drawn by each lamp. **10marks**

19. Three identical loads each having a resistance of 10Ω and an inductive reactance of 20Ω are connected first in star and then in delta across a 415V, 50 Hz three-phase supply. Calculate the line and phase currents in each case. **10marks**

20. A four-pole cage induction motor is run from a 50 Hz supply and has a slip of 3%. The rotor shaft drives a pulley wheel 300 mm in diameter, which has a tangential force of 200 N exerted upon it. Calculate the power output from the rotor in watts. **10marks**

21. A 250 W sodium-vapour street lamp emits a light of 22 500 cd and is situated 5 m above the road. Calculate the luminance (a) directly below the lamp and (b) at a horizontal distance along the road of 6 m. **10marks**

22. A transformer has 600 primary turns and 150 secondary turns. The primary and secondary resistances are 0.25Ωand 0.01Ωrespectively and the corresponding leakage reactance are 1.0Ωand 0.04Ω respectively. Determine (a) the equivalent resistance referred to the primary winding, (b) the equivalent reactance referred to the primary winding, (c) the equivalent impedance referred to the primary winding, and (d) the phase angle of the impedance. **10marks**

Section III. Choose and answer any one (1) question. **15marks**

23. A 400 kVA transformer has a primary winding resistance of 0.5Ω and a secondary winding resistance of 0.001Ω. The iron loss is 2.5kW and the primary and secondary voltages are 5 kV and 320V respectively. If the power factor of the load is 0.85, determine the efficiency of the transformer (a) on full load, and (b) on half load. **15marks**

24. A) A single phase a.c. generator supplies the following loads

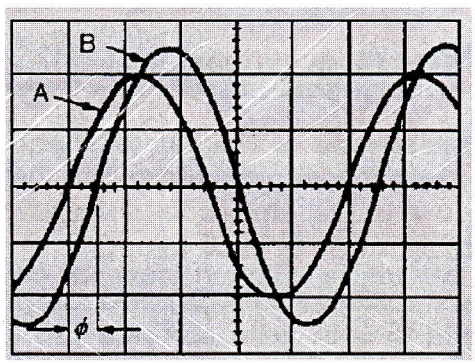
(i) Lighting load of 20 kW at unity power factor.
(ii) Induction motor load of 100 kW at p.f. 0·707 lagging.
(iii) Synchronous motor load of 50 kW at p.f. 0·9 leading.

Calculate the total kW and kVA delivered by the generator and the power factor at which it works.

B) A 100 MW power station delivers 100 MW for 2 hours, 50 MW for 6 hours and is shut down for the rest of each day. It is also shut down for maintenance for 45 days each year. Calculate its annual load factor.

15marks

25. A) For the double-beam oscilloscope displays shown in figure below determine (a) their frequency, (b) theirr.m.s. values, (c) their phase difference. The 'time/cm switch is on 100 μs/cm and the 'volts/cm switch on 2V/cm.



B) The power supplied to a three-phase induction motor is 32kW and the stator losses are 1200W. If the slip is 5 per cent, determine (a) the rotor copper loss, (b) the total mechanical power developed by the rotor, (c) the output power of the motor if friction and windage losses are 750W, and (d) the efficiency of the motor, neglecting rotor iron loss.

15marks