00071

THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
DEPARTMENT OF ELECTRICAL & COMPUTOR ENGINEERING

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: EEX4448 -Electrical Machines
Academic Year	: 2021/22
Date	: 08th March 2023
Time	: 0930-1230 hrs
Duration	: 3 hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Eight (8)** questions in **Four (4)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. No relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use red colour pen.

Q1

a) A 300/400V ideal power transformer which has 60 turns in the primary winding is shown in the figure Q1. Cross-sectional area of the transformer core is 80 cm^2. The transformer primary side is supplied by a 300 V, 50 Hz source.

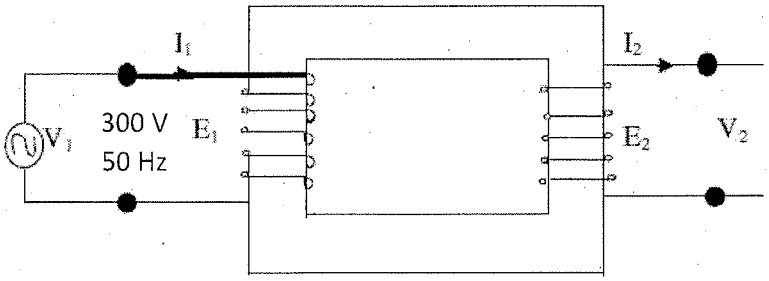


Figure Q1

Calculate,

i. the number of turns in the secondary winding [2 marks]
ii. the induced emf per turn [2 marks]
iii. the peak flux in the core [2 marks]
iv. the peak flux density in the core [2 marks]

b) Calculate the current flowing through both primary and secondary sides when a 900 Ω load is connected to the secondary side of the transformer. [4 marks]

c) A three phase 1100 kVA, 3.3/11 kV transformer has the primary winding delta connected and the secondary winding star connected. The resistance and leakage reactance of each phase of the primary winding are 0.6 Ω and 3.2 Ω respectively, and the corresponding values of each phase of the secondary winding are 4.8 Ω and 22.6 Ω. Calculate the secondary terminal voltage at full load when the primary is supplied at 3.3 kV. Ignore the magnetizing current and core losses. Assume power factor to be unity. [8 marks]

Q2

a) Write four (04) advantages of an auto transformer. [8 marks]

b) An autotransformer shown in figure Q6 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 $N_{AC} = 100$ and another tapping at B such that $N_{BA} = 50$. Calculate currents in various parts of the circuit and show their directions when 400 V supply is connected across AC and two resistive loads of 60 Ω and 40 Ω are connected across BC and DC respectively. [12 marks]

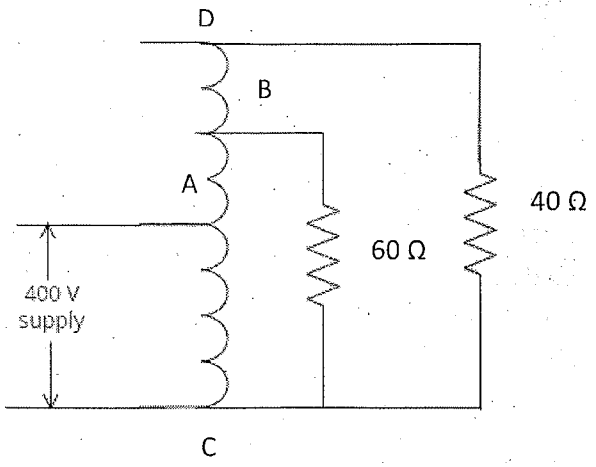


Figure Q2

Q3

a) Briefly state why the DC series motor should never be started on no load? [3 marks]

b) Explain the building up of voltage of a shunt generator at no load with suitable voltage-current characteristics. [5 marks]

c) A 1000 kVA, 11 kV three- phase alternator has winding's per phase ac resistance of 0.32 Ω. The open circuit (OC) and short circuit (SC) tests results of the alternator is given below.

OC Test: Field current =14.5 A, voltage between line = 432 V
SC Test: Field current =14.5 A, line current = 50.5 A
Determine the full-load voltage regulation of the alternator at,
i. 0.8 power factor lagging [6 marks]
ii. 0.8 power factor leading [6 marks]

Q4

a) State three (03) starting methods of squirrel cage induction motors. [3 marks]

b) Briefly explain a method which can be used to determine equivalent circuit parameters of an induction motor with appropriate circuit diagrams/graphs. [8 marks]

c) Briefly explain the speed and torque characteristics of a DC shunt motor. [9 marks]

Q5

a) List three (03) speed controlling methods of an induction motor and briefly explain one of the methods. [7 marks]

b) What is the rotor speed of 6 pole 50 Hz synchronous generator? [3 marks]

c) A 440 V, 50 Hz, 6 pole, three- phase mesh connected synchronous motor is supplied by the rated voltage. The line current and the power factor of the load is 236 A and 0.92 respectively. Calculate the power and torque of the motor. [10 marks]

Q6

a) What are the three (03) methods of electrical breaking of an induction motor? Briefly explain one of the braking methods. [8 marks]

b) State the two types of armature windings in DC machines. [4 marks]

c) Two number of alternators are working in parallel with their terminal voltage equal to the rated value. One of the machines, which has a synchronous reactance of 50% and a resistance of 3%, delivers a power output in kW equal to 80% of its rated kVA. If the emf of this unit equals 1.3 times the terminal voltage, find out the power factor at which the machine is operating.

[*Given:* $E_f^2 = (V_t cos\theta + I_a r_a)^2 + (V_t sin\theta + I_a X_s)^2$ *where* E_f *is the induced emf,* V_t *is the terminal voltage,* r_a *is the armature resistance and* X_s *is the synchronous reactance.*

Take $(A \cos\theta + B \sin\theta) = \sqrt{A^2 + B^2}\, sin\,(\theta + tan^{-1}\frac{A}{B})$] [8 marks]

Q7

a) State two (02) speed control methods applied to DC motors. [4 marks]

b) A 6 pole DC machine has 300 conductors and each conductor is capable of carrying 60A without excessive temperature rise. The flux per pole is 0.03Wb and the machine is driven at 2400 rpm. Compute the total current, emf., power developed in the armature and electromagnetic torque, if the armature conductors are

1) wave connected [8 marks]
2) lap connected [8 marks]

Q8

a) Briefly explain how electrical energy is converted into mechanical energy of rotation. [3 marks]

b) Under steady operation of a 10 pole, three phase induction motor the rotor speed was found to be 500 rpm. If the synchronous speed is 600 rpm, find

i. frequency of excitation [2 marks]
ii. percentage slip [3 marks]

iii. frequency of rotor induced voltage [2 marks]

iv. speed of the rotor produced magnetic field with respect to rotor itself. [3 marks]

c) State three (03) starting methods of an induction motor and briefly explain one of the methods. [7 marks]