CHUKA  UNIVERSITY



**UNIVERSITY EXAMINATIONS**

**EXAMINATION FOR THE AWARD OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING**

**EEENG 342: ELECTRICAL MACHINE Ⅱ**

**STREAMS: BSC EENG** **TIME:2 HOURS**

**DAY/DATE: TUESDAY 23/12/2024** **11.30 A.M. –1.30 P.M**

**INSTRUCTIONS:**

- **Answer question ONE and any other TWO questions**
- **Do not write on the question paper**

**QUESTION ONE (30 MARKS)**

a) Outline FOUR conditions for parallel operation of a 3-phase transformer. [4 Marks]

b) A 220-V three-phase six-pole 50 Hz induction motor is running at a slip of 3.5 percent .Find:

i. The speed of the magnetic fields in revolution per minute [1 Marks]
ii. The speed of the rotor in revolutions per minute [1 Marks]
iii. The slip speed of the rotor [1 Marks]
iv. The rotor frequency in hertz [1 Marks]

c) A 25 kVA, single phase transformer has 250 turns on the primary and 40 turns on the secondary winding. The primary is connected to 1500-volt, 50 Hz mains. Calculate:

i. Primary and secondary currents on full-load, [2 Marks]
ii. Secondary e.m.f, [1 Marks]
iii. Maximum flux in the core. [1 Marks]

d) Explain the major advantages of operating two or more alternators in parallel in a power system. [4 Marks]

e) A 3-phase, 6,600V, 50Hz, star-connected synchronous motor takes current of 50A. The resistance and synchronous reactance per phase are 1 Ω and 20 Ω respectively. For a power factor of 0.8 leading, determine the;
   i. Power supplied to the motor. [2marks]
   ii. Resultant voltage per phase due to star impedance. [2marks]

f) Explain the term 'slip' as applied to three phase induction motors. [2marks]

g) 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
   i. Primary and secondary turns [2 Marks]
   ii. Area of the core. [2 Marks]

h) Front four desirable properties of insulating materials used in the design of electrical machines. [4 Marks]

**QUESTION TWO (20 MARKS)**

a) A 400V, 50Hz, 6-pole, 3-phase, star-connected synchronous motor has a synchronous impedance per phase of (0.5+j4.0) Ohm. On full load, the excitation is adjusted so that the machine takes an armature current of 60A at power factor of 0.866 leading. Excitation and mechanical losses are estimated at 2Kw. Calculate;
   i. The back e.m.f. [4marks]
   ii. Maximum power developed in the armature. [3marks]
   iii. Total copper losses in armature windings. [2marks]

b) A 6600 V , 3 phase , star connected synchronous motor draws a full-load current of 80 A at 0.8 p.f.leading. The armature resistance is 2.2 Ω and reactance 22 Ω per phase. If the stray losses of the machine are 3200 W. Find:
   i. E.m.f induced, [6 Marks]
   ii. Output Power [3 Marks]
   iii. Efficiency of the machine. [2 Marks]

**QUESTION THREE (20 MARKS)**

a) A 2-pole,240V, 50Hz, single phase induction motor has the following constants referred to the stator. $R1 = 2.2\Omega$; $X1 = 3.0\Omega$; $R'2 = 3.8\Omega$; $X'2 = 2.1\Omega$; $Xm = 86\Omega$ Find the stator current and the input power when the motor is operating at a full load speed of 2820 r.p.m. [10marks]

b) With the aid of a diagram, explain the operation of a single phase induction motor using the Double field revolving theory. [6 Marks]

c) Describe TWO characteristics of the 3-phase induction motor fitted with a wound (slip-ring) rotor and suggest TWO suitable applications. [4 Marks]

**QUESTION FOUR (20 MARKS)**

a) Two transformers A and B, both of no-load ratio 1000/500-V are connected in parallel and supplied at 1000 V. A is rated at 100 kVA, its total resistance and reactance being 1% and 5% respectively, B is rated at 250 kVA, with 2% resistance and 2% reactance. The transformers have a total load of 300 kVA at 0.8 lagging power factor. Determine:
   i. The load on each transformer, [6 Marks]
   ii. Secondary voltage. [3 Marks]

b) With the aid of a diagram, describe rotor rheostat method of starting three phase induction motors fitted with wound rotors. [4 Marks]

c) Determine the core area, the number of turns and the position of the tapping point for a 500-kVA, 50-Hz, single-phase, 6600/5000-V auto-transformer assuming the following approximate values : e.m.f. per turn 8 V. Maximum flux density 1.3 $Wb/m^2$. [4 Marks]

d) What are the advantages of slip-ring induction motors over the squirrel caged motors. [3 Marks]

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