D 23455 (Pages : 3) Name..............................

Reg. No..............................

THIRD SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION, JANUARY 2003

EC2K 306 / A12K 306 ELECTRICAL ENGINEERING

(New Scheme)

Time : Three Hours Maximum : 100 Marks

Answer **all** *questions.*

1. (a) From first principles derive the e.m.f. equation of a D.C. machine. Write the units of all parameters involved in the expression.

   (b) What is a starter ? What is its need for starting a large motor ? What is the basis for selecting a starter ?

   (c) Draw the vector diagram of a transformer supplying a leading power factor load.

   (d) What is an auto-transformer ? Show how copper can be saved in an auto-transformer as compared to equivalent two winding transformer.

   (e) Show how a rotating magnetic field is produced by a 3-phase symmetrical winding.

   (f) A 3-phase, 50 Hz, 400 V induction motor runs at 288 r.p.m. on full-load. Find (i) the slip ; (ii) frequency of rotor induced current ; and (iii) speed of rotor field with respect to stator field.

   (g) Explain the working of dynamometer wattmeter.

   (h) What are the limitations of Wheatstone bridge ? Show how they are overcome in a Kelvin double bridge.

   ($8 \times 5 = 40$ marks)

2. (a) Derive from basics an expression for the torque developed by a D.C. motor interms of flux and other parameters. Hence derive the torque speed characteristic of series motor.

   (8 marks)

   (b) A 4-pole, shunt generator with lap connected armature having field and armature resistances of 50 Ω and 0·1 Ω supplies sixty, 100 V, 60 W lamps. Calculate the armature copper loss, current in each armature conductor and the generated e.m.f. Allow a contact drop of 1 V per brush.

   (7 marks)

   Or

   (c) Draw the circuit schematic of a 3-point starter with all protective features. Explain its working.

   (8 marks)

(d) The magnetisation characteristics of a 4-pole, 250 V, shunt generator with 576 lap connected armature conductors at 1,000 r.p.m. is as follows :

Field amp. :	0	0·5	1·0	2·0	3·0	4·0	5·0
Terminal volts :	10	50	100	175	220	245	262

Determine : (i) critical field resistance ; (ii) critical speed if field circuit resistance is 100 Ω ; and (iii) the residual flux per pole.

(7 marks)

3. (a) Explain the constructional details of a 3-phase core type transformer. What is a cruciform core ? Why it is used in large transformers ?

(7 marks)

(b) A 50-Hz, 1-phase transformer has a turn ratio of 6. The resistances are 0·90 Ω and 0·03 Ω, and the reactances 5Ω and 0·13 Ω for LV and HV windings respectively. Find (i) the voltage to be applied to HV winding to obtain full-load current of 150 A in the LV winding on short circuit ; (ii) the power factor on short circuit ; and (iii) copper loss at $\frac{3}{4}$ load.

(8 marks)

Or

(c) Draw circuit diagrams with proper meter ratings to conduct OC and SC tests on a 200 kVA, 400/230 V, 50 Hz, single-phase transformer. Explain the test procedure.

(8 marks)

(d) Determine the number of turns per phase in each winding of a 3-phase transformer with a ratio of 20000/2000 V to work on a 50 Hz network. The HV winding is delta connected and the LV winding is Y connected. Each core has a gross section is 560 cm.^{2} Assume a flux density of about 1·2 tesla.

(7 marks)

4. (a) Derive from basics an expression for the e.m.f. induced in a 3-phase, Y-connected armature with double layer windings taking into account coil span and distribution of windings. What is the basis of selection of coil span ?

(8 marks)

(b) An 8-pole, 50-Hz, 3-phase induction motor has an equivalent rotor resistance of 0·07 Ω per phase. If its stalling speed is 630 r.p.m., how much resistance must be included per phase to obtain maximum torque at starting ? Ignore magnetizing current.

(7 marks)

Or

(c) Draw and explain the vector diagram of a 3-phase induction motor when it is working with slip S.

(7 marks)

(d) The excitation of a 415 V, 3-phase, mesh connected synchronous motor is such that the induced e.m.f. is 520 V. The impedance per phase is 0·5 + *j* 4 Ω. If the friction and iron losses are constant at 1000 W, calculate the power output, line current, power factor and efficiency for : (i) maximum power output ; and (ii) maximum power input.

5. (a) Show by relevant circuit and vector diagrams two wattmeters are enough to measure total power in a 3-phase balanced circuit. Derive expressions for reading of each wattmeter and power factor of the load.

(8 marks)

(b) A standard cell of 1·0185 V used with a simple potentiometer balances at 50 cm. Calculate :

(i) the e.m.f. of a cell that balances at 72 cm. ;

(ii) the percentage error in a voltmeter which balances at 64·5 cm. when reading 1·33 V ;

(iii) the percentage error in an ammeter that reads 0·43 A when balance is obtained at 43·2 cm. with the potential difference across a 2Ω resistor in the ammeter circuit.

(7 marks)

Or

(c) Draw the circuit schematic of Schering bridge and from basics obtain expressions for the unknown impedance. Draw the vector diagram of balanced bridge.

(8 marks)

(d) The power input to a 2000 V, 50-Hz, 3-phase motor, running on full-load at an efficiency of 90 % is measured by two wattmeters. If the output is 360 kW and motor power factor is 0·8 lagging, find (i) power input to the motor ; (ii) reading of each wattmeter ; and (iii) the line current.

(7 marks)

[4 × 15 = 60 marks]