REF No:Ex/PE/PC/B/T/226

Bachelor of Power Engineering 2nd Year 2nd Semester Examination 2023

Subject: **Electrical Motors and Drives**

Full Marks 100

Time 3 Hour

PART A (50 Marks)

Q1(CO1) Any Five (5x1 = 5)

1. Which braking is not possible in series motor?
(A) Regenerative braking.
(B) Dynamic braking.
(C) Plugging.
(D) None of the above

2. To save energy during braking----------braking is used?
(A) Dynamic
(B) Plugging
(C) Regenerative
(D) all of the above

3. A four quadrant operation requires
(A) two full converters in series.
(B) two full converters connected in parallel.
(C) two full converter connected in back to back.
(D) two semi converters connected in back to back.

4. Speed control by variation of field flux results in
(A) constant power drive.
(B) constant torque drive.
(C) variable power drive.
(D) none of the above.

5. High braking torque produced in
(A) plugging.
(B) dynamic braking.
(C) regenerative braking.
(D) none of above.

6. Which speed control method preferred for constant torque drive?
(A) Field control.
(B) Armature voltage control.
(C) Mechanical loading system.
(D) None of above.

7. Duty cycle (D) is _____
(A) Ton÷Toff
(B) Ton÷(Ton+ Toff)
(C) Ton÷2×(Ton+ Toff)
(D) Ton÷2×Toff

8. The shape of the speed-torque characteristics in DC shunt motor is _____
(A) Rectangular Hyperbolic
(B) Whole x-y plane
(C) Circle
(D) Ellipse

Q2 (CO2) Any Five (5x1=5)

i) Why the starting Power Factor of an Induction Motor is very Poor

ii) What are different methods of Speed Control of Induction Motor

iii) What is regenerative generation for Induction Motor

iv) What is back EMF for DC Motor

v) How the efficiency of a DC Motor can be found out

vi) What are the different losses of a DC Motor

vii) How the Mechanical Load is reflected in the Equivalent Circuit of an Induction Motor

viii)What do you mean by duty cycle of a chopper?

ix) What are the methods of speed control in DC motors

x) What do you mean by continuous conduction?

xi)) What do you mean by discontinuous conduction?

xii)) Why chopper based DC drives give better performance than rectifier controlled drives.

Q3 (CO3) Any Five (5x2 =10)

i) What is Dynamic Braking of DC Motor

ii) What is Plugging for Induction Motor

iii) Why Starter is required for DC Motor

iv) What is Rotor Resistance Control for Induction Motor

v) Draw the Torque Current Characteristics of DC Series Motor and Explain

vii) Draw and explain the drive circuit for single-phase half-controlled rectifier control of dc separately excited motor.

viii) Draw and explain the drive circuit for three-phase fully-controlled rectifier control of dc separately excited motor.

ix) Explain in brief with a diagram the dual converter scheme for Multiquadrant Operatio of DC Seperately Excited motor fed from a fully controlled rectifier.

x) Draw the drive circuit for motoring control of chopper controlled separately excited DC motor drive

Q4 (CO4) Any Three (3x10 = 30)

i) A 220 V, 50A, 1000 rpm D.C shunt motor has armature resistance of 0.2 ohm. If load torque is reduced to 60 % of its full-load value and a resistance of 2 ohm is inserted in series with armature circuit, Find the motor speed .Armature reaction weakens the field flux by 4 % at full load and by 2 % at 60 % of full load.

ii) A 3-phase slip ring induction motor has a synchronous speed of 1500rpm and develops 4hp at 1410 rpm. Calculate the stator input if the stator power loss is 500W. If a resistance is inserted in the rotor circuit so that the mechanical power is 5HP at 1100rpm, then calculate the stator input assuming stator losses to be 125% of previous value.

iii) A 240 V, 24A, 1200 RPM, DC separately excited motor has an armature resistance of 2 Ω. The motor is controlled by a Chopper with a frequency of 500 Hz from a supply of 230 V. Calculate the duty ratio δ for 1.2 times the rated Torque and 500 RPM.

iv) A 220V, 970 RPM, 100 A DC separately excited motor has an armature resistance of 0.05 Ω. It is braked by plugging from an initial speed of 1000 RPM. Calculate: a) Resistance to be placed in the armature circuit to limit braking current to twice the full load value. b) Braking torque c) Torque when the speed has fallen to zero.

v) A 440 V, 50 Hz, 4 pole, 1420 rpm, delta-connected squirrel-cage induction motor has the following parameters:

R_s= 0.5 Ω, R_r'= 0.4 Ω, X_s= 0.5 Ω X_r'= 1 Ω.

The motor is fed from a voltage source inverter. The drive is operated with a constant (V/f) control upto 50 Hz and at rated voltage above 50 Hz.

i) Calculated the breakdown torques for the frequency of 75 Hz both for motoring and braking operations.
ii) Frequency for motoring operation at 950 rpm and full-load torque

vi) A 1-phase, 220 V, 50 Hz, 1410 rpm induction motor has the following parameters:

R_s= 2.3 Ω, R_r'= 3.6 Ω, X_s= X_r'= 2.5 Ω, X_m= 60 Ω

The motor drives its fan load at rated speed when rated voltage is applied.

A. What resistance should be connected in series with the motor to reduce its speed to 1190 rpm?

B; What voltage should be applied to the motor to reduce its speed to 1190 rpm?

vi) A 3-phase, 440 V, 4 pole, 50 Hz, Y-connected slip-ring induction motor has the following parameters referred to the stator:

$R_s = 0.55\ \Omega$, $R_r' = 0.8\ \Omega$, $X_s = 2.5\ \Omega$ $X_r' = 1.8\ \Omega$.

The speed of the motor is reduced to 700 rpm at half full load torque by injecting a voltage in phase with the source voltage into the rotor. Calculate the magnitude and the frequency of the injected voltage. Stator to rotor turns ratio is 2.

B.E. POWER ENGINEERING SECOND YEAR SECOND SEMESTER EXAMINATION 2023

ELECTRICAL MOTORS AND DRIVES **Part-II** **Ref. No.: Ex/PE/PC/B/T/226/2023**

Full Marks : 50

Q1. Answer any three questions: 3×2

(a) Draw the block diagram of an electrical drive system and explain its operation.
(b) What are the functions of the power modulators?
(c) Write down the fundamental torque equation of a motor load system and explain each component of the equation.
(d) Explain the forward motoring and forward braking through the four quadrant operation of a motor driving a hoist load.
(e) Explain the operation of choppers or dc-dc converters.

Q2. Answer any four questions: 4×3

(a) Why does synchronous motor develop torque only at synchronous speed? Explain.
(b) Draw the armature current locus of synchronous motor for constant excitation operation.
(c) Draw and explain the phasor diagram of salient pole synchronous motor operating at lagging power factor.
(d) Derive the expression of maximum power output in cylindrical rotor synchronous motor.
(e) Explain the operation of a synchronous condenser? Draw the phasor diagram.
(f) What happens when the load on the synchronous motor is increased? What is hunting? How can it be avoided?
(g) What is the Hysteresis Synchronous Motor? What are its applications?

Q3. Answer any two questions: 2×4

(a) Derive the expression for torque of Brushless DC motor supplied from a current regulated voltage source inverter. Draw the corresponding voltage, current and torque waveforms.
(b) Which type of braking is useful to stop or decelerate a load driven by a synchronous motor? Draw the equivalent circuit of the corresponding braking system and find the torque expression.
(c) Explain the operation of the self-controlled synchronous motor drive with load commutated thyristor inverter for motoring operation.
(d) Draw the block diagram of closed loop speed control of load commutated inverter synchronous motor drive and explain the corresponding speed control operation.

Q4. Answer any three questions: 3×8

(a) A salient pole synchronous motor delivers rated mechanical output at rated voltage and takes rated current at 0.8 pf leading. Calculate the excitation emf if $X_d=1.2pu$ and $X_q=1.0pu$. Draw the phasor diagram.
(b) A 400 V, 3 phase system supplies a 300 kVA load at 0.7 pf lagging. A synchronous motor supplying 80 bhp mechanical load is connected to improve the pf. If the synchronous motor is operating at 0.8 pf leading find the total kVA, total active power and overall power factor.
(c) A 1500 hp, 2000 V, 20 pole, star connected 50 Hz synchronous motor has a reactance of 2.00 ohm per phase. The motor is supplied from a constant voltage system at 2000 V. Its field excitation is so adjusted that the power factor is unity at rated load. Calculate the maximum torque which the motor can develop. Neglect losses.
(d) A 1 MVA, 3.3 kV, 50 Hz, 6 pole round rotor synchronous motor has a resistance of 0.01 pu and synchronous reactance of 0.8 pu. If the excitation emf is 1.4 pu, then find the value of maximum power input, the armature current and the power factor.
(e) A 1200 kW, 6.6 kV, 3 phase, 50 Hz, 6 pole, UPF, star connected synchronous motor is controlled by a load commutated inverter and line commutated converter. The synchronous reactance of the motor is 2.0 ohm and its resistance is neglected. Load commutated inverter operates at 150° and rectifies at 0°. The DC link inductor resistance is 0.25 ohm. If the drive operates in self-controlled mode with constant (V/f) ratio, then find the source side firing angle for (i) the synchronous motor operating with rated current at 750 rpm and (ii) the regenerative braking operation with rated current at 750 rpm.