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| **Name:**<br>**Enrolment No:** | UPES |

**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**
**End Semester Examination, December 2018**

**Programme : B.TECH (ICE)** **Semester – VII**
**Course Name: Industrial Drives** **Max. Marks : 100**
**Course Code: PSEG-424** **Time: 03 hrs.**
**Instructions:**

**SECTION A**

| S. No. | | Marks | CO |
|---|---|---|---|
| Q 1 | In an electrical drive system the Energy conservation can achieved by reducing the losses, list of the various losses associated with the drive system. | **5** | **CO1** |
| Q2 | Draw the speed torque curves of separately excited and DC series motor in the case of Dynamic breaking. | **5** | **CO2** |
| Q3 | Explain the reasons for using load equalization in an electrical drive ? | **5** | **CO4** |
| Q4 | Discuss the main factors influencing the selection of electric drives for industrial applications? | **5** | **C01** |
| | **SECTION B(**Internal choice Q6 or Q7) | | |
| Q 5 | Electric motors are used, and to control them electrical drives are employed. But the operating time for all motors is not the same. Some of the motors run all the time, and some of the motor's run time is shorter than the rest period. Depending on this, explain the concept of classification of motor duty class depending up on their application in detail with the help of Torque Vs Time characteristics. | **10** | **CO1** |
| Q6 | Explain how below mentioned breaking techniques are employed for an DC shunt motor with the help of slip-torque characteristics.<br>i. Regenerative braking<br>ii. Dynamic braking | **10** | **C02** |
| Q7 | A separately excited dc motor has the following parameters:<br>Ra=0.5Ω , Laq≈0 , B≈0;<br>The motor generates an open-circuit armature voltage of 220 V at 2000 rpm and with a field current of 1.0 ampere. The motor drives a constant load torque $T_L$ =25 N.m. The combined inertia of motor and load is J = 2.5 kg .m2. With field current $I_f$ 1.0 A, the armature terminals are connected to a 220 V dc source.<br>(a) Derive expressions for speed ($\omega_m$) and armature current ($i_a$) as a function of time.<br>(b) Determine the steady-state values of the speed and armature current | **10** | **CO4** |
| Q8 | Explain the closed loop rectifier controlled DC motor drive with speed and current control. | **10** | **CO3** |
| Q9 | Show that a variable frequency induction motor drive , develops at all frequencies the same torque for a given slip-speed when operation at constant flux. consider IEEE equivalent circuit | **10** | **CO3** |
| | **SECTION-C (**Internal choice Q11 or Q12) | | |
| Q 10 | A 2hp, 110V , 1200 rpm separately excited DC Motor. fed from a Single phase full converter connected to a single phase 120V ,50 Hz, supply Having machine Parameters : Ra=0.4 Ohms, La=5m H , Motor constant :Kϕ=0.09 V/rpm During the motor operation Motor runs at 1000rpm , draws a line current of 30A, assuming the | **20** | **CO4** |

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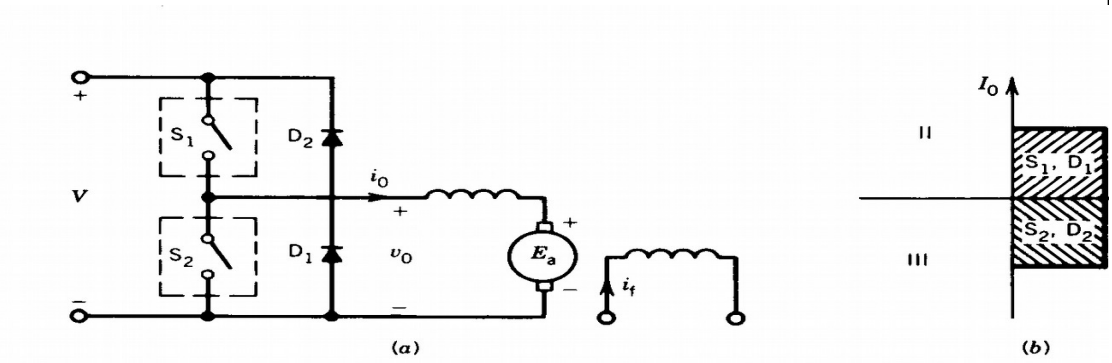
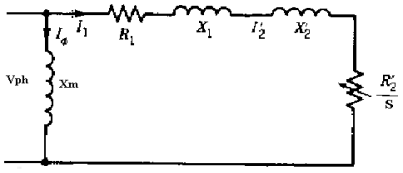
| | motor current is ripple free determine the supply power factor.<br>During the inverter operation (regeneration action), the polarity of the motor backemf Ea is reversed , say by reversing the field excitation determine the firing angle to keep the motor at 30A with the speed 1000rpm | | |
| Q11 | The two-quadrant chopper shown in Fig. below is used to control the speed of the dc motor and also for regenerative braking of the motor. The motor constant is Kϕ V/rpm (Ea = Kϕn). The chopping frequency is f Hz and the motor armature resistance is Ra Ω The inductance La is sufficiently large and the motor current $i_o$ can be assumed to be ripple-free.<br>The supply voltage is V.<br>  <br><br>Explain how forward motoring and regenerative breaking is achieved with the help of corresponding equivalent circuit and draw waveforms of $V_0$, $i_0$, and $i_s$. | **20** | **C02** |
| Q12 | A 3-ϕ star connected 6 pole 50 Hz ,440V 925 rpm ,Squirrel cage induction motor has the following parameters<br>Rs=0.2Ω, $R_r'$=0.3Ω , Xs=0.5 Ω, $X_r'$=1 Ω<br>Motor speed is controlled from a V/F control fed from a voltage source inverter with a constant V/f ratio from 0 to 50Hz.<br>Consider Voltage of 440V for above 50Hz<br>i) Determine the starting and maximum torque for a frequency of 100Hz as a ratio of its values at 50Hz<br>ii) Obtain the torque at rated motor current at 25Hz<br>Note: :consider below circuit for the analysis<br>  <br> | **20** | **C03** |

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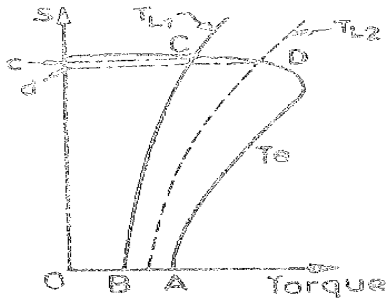
**Instructions:**

## SECTION A

| S. No. | | Marks | CO |
|---|---|---|---|
| Q 1 | Explain is the advantage of freewheeling diode in a rectifier fed DC Drives ? Discuss | **5** | **CO2** |
| Q2 | Explain the possible solutions to improve the starting torque of 3 phase induction motor? | **5** | **CO4** |
| Q3 | Explain the need of current sensing is required in electrical drives ? | **5** | **C01** |
| Q4 | Due to inadequate reactive power compensation ,the motor terminal voltage varies , explain how the quality of the supply can be improved | **5** | **C04** |
| **SECTION B**(Internal choice Q6 or Q7) | | | |
| Q 5 | Practically all the motors, the speed will drops as the load torque changes, mere intersection of the motor torque and load torque characteristics does not guarantee a stable operating point, so in order to have stable equilibrium operating point derive the condition for system to be stable. Initially the motor is having an operating point C with the load torque ($T_{L1}$), If the load changes from $T_{L1}$ to $T_{L2}$ Analyze that the Point C is a Stable operating point or not   | **10** | **CO1** |
| Q6 | A 220 V, 1500 rpm, 20 A separately excited dc motor has an armature resistance of 0.5 Ω. It is fed from a single phase fully controlled bridge rectifier with an ac source voltage of 230 V, 50 Hz. Assuming continuous load current, compute motor speed at the firing angle of $60^0$ and torque of 10 Nm. Also compute developed torque at the firing angle of $45^0$ and speed of 1000 rpm. | **10** | **C04** |
| Q7 | Analyze the stepdown chopper with DC Motor (RLE Load) and derive the expression for the peak-peak ripple current and find out the boundary condition for continuous current. | **10** | **C03** |
| Q8 | Explain how below mentioned breaking techniques are employed for an DC shunt motor with the help of slip-torque characteristics.<br>i. Dynamic braking<br>ii. Plugging | **10** | **C02** |
| Q9 | Explain which type of chopper circuit used to achieve all quadrant operation only of a separately excited DC-motor driving a hoist load. With the help of the circuit diagram , Voltage Vs Current Quadrant , Torque Vs Speed Quadrants and necessary | **10** | **C03** |

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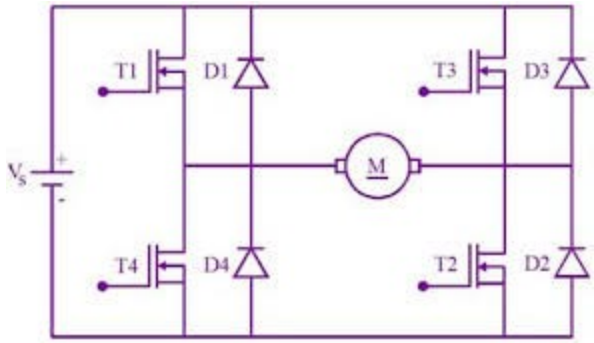
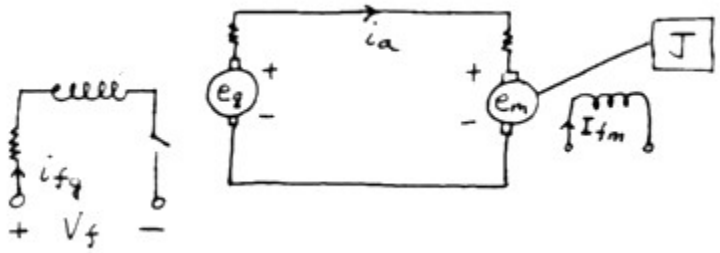
| | output wave forms. And also explain how the regenerative breaking can be achieved. | | |
| | **SECTION-C(**Internal choice Q11 or Q12) | | |
| Q10 | The four-quadrant chopper shown in Fig. below is used to control the speed of the dc motor and also for regenerative braking of the motor. The motor constant is Kϕ V/rpm (Ea = Kϕn). The chopping frequency is f Hz and the motor armature resistance is Ra Ω The inductance La is sufficiently large and the motor current $i_o$ can be assumed to be ripple-free.<br>The supply voltage is V.<br>  <br><br>Explain how all for quadrant operation is achieved with the help of corresponding equivalent circuit. | **20** | **CO3** |
| Q11 | A motor-generator set consists of a dc generator and a dc motor whose armatures are connected in series. The generator is driven at the rated speed and the motor field current is kept constant at its rated value. The machines have the following parameters.<br>  <br><br>The rotational losses and the armature inductances are negligible. The motor is coupled to an inertia load and the combined inertia of the motor and load is J<br>a)Write the governing mathematical equations for the motor and generator .<br>b)Do the mathematical modelling in s-domain for DC-Motor only and obtain the open loop block diagram. | **20** | **C04** |
| Q12 | A 3-Phase , 15hp, 1400 rpm, 415V , 50Hz, 4 Pole star connected induction motor has the following parameters<br>Rs=0.55Ω , $R_r$' =0.3Ω , Xs= 1Ω , Xr'=1.2Ω and $X_m$= 30 Ω<br>Neglect no load losses . A current source inverter keeping input current at 20A feeds this induction motors. If the torque developed at 30 Hz frequency is 40Nm, determine the a) slip for maximum torque and its value b)slip | **20** | **C02** |