2012-13
B.TECH. (WINTER SEMESTER) EXAMINATION
ELECTRICAL ENGINEERING
ELECTRICAL DRIVES
EE413N

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.           Question                                             M.M.
1(a)            Explain that the steady-state stability of a drive depends on relative characteristics [06] of the motor and load and not just on motor (or load) characteristics. Derive the relation that explains the above fact.
1(b)            A motor has a continuous rating of 100 kW. The heating and cooling time constants are 50 and 70 minutes respectively. The motor has a max efficiency at 80% full load and is employed in an intermittent periodic load cycle consisting of a load period of 10 minutes followed by no-load period of 10 minutes. Calculate the value of the load in kW during the load period.

OR

1'(a)           Why load equalization is used in drives? Draw the speed-torque characteristics of such a drive. Derive the relation for the moment of inertia of the flywheel required to be placed on the shaft of the motor load system.
1'(b)           A drive consisting of semiconductor converter fed DC motor, runs according to the following duty cycle:

                    (i) Acceleration from standstill to 1000 rpm in 10 sec. at uniform acceleration.
                    (ii) Running at 1000 rpm and 800 Nm torque for 8 sec.
                    (iii) Braking from 1000 rpm to standstill in 10 sec. at uniform deceleration.
                    (iv) Remains idle for 20 sec.

Determine the torque and power ratings of the machine. Assume forced cooling and constant field current. Take \( J = 100 \text{ kg} \cdot \text{m}^2 \).

2(a)            Give the neat circuit diagrams for chopper controlled separately excited dc motor [06]
for its motoring and regenerative braking operations. With the help of relevant waveform of armature voltage and current derive the expression for motor speed as a function of torque in terms of duty ratio (D) and dc source voltage (V_d) for the regenerative braking operation. Duty ratio is the ratio of duty interval to the time period.

2(b) A 230 V, 1200 rpm, 15 A separately excited motor has armature circuit resistance and inductance of 1.8 Ω and 32 mH respectively. This Motor is controlled by a single-phase fully-controlled rectifier with an ac source voltage of 230 V, 50 Hz. Identify modes and calculate speeds for α = 45° and torque = 40 N-m.

OR

2'(a) Describe various braking methods of dc motors and explain their important features.

2'(b) A dc series motor coupled to a fan load is controlled by variation of armature voltage. When armature voltage is 400 V, motor takes 20 A and the fan speed is 250 rpm. The combined resistance of armature and field is 1.0 Ω. Calculate:

(i) the motor armature voltage for the fan speed of 350 rpm.

(ii) the motor speed for the armature voltage of 250 V.

3(a) Explain the principle of rotor resistance control for speed control of three-phase induction motor. Give the neat circuit diagram of static rotor resistance control. With the help of relevant waveform(s) derive the expression of per phase rotor resistance that the dc side resistance ‘R’ will offer in terms of the duty ratio ‘D’ of the static switch, where 0 < D < 1.

3(b) A 3-phase, 440 V, 50 Hz, 6 pole, 970 rpm, Y-connected induction motor has following parameters referred to stator:

\[ R_s = 0.2 \, \Omega, \quad R_g = 0.15 \, \Omega, \quad X_s = X_g = 0.4 \, \Omega \]

The stator to rotor turns ration is 3.5. The motor speed is controlled by Static Scherbius Drive. The drive is designed for a speed range of 30% below the synchronous speed. The maximum value of firing angle is 170°. Calculate:

(i) turns ratio of the transformer.

(ii) torque for a speed of 750 rpm and α = 140°.

(iii) firing angle for half the rated motor torque and a speed of 850 rpm.
3'(a) Explain how dynamic braking is implemented in three-phase induction motor. 

3'(b) What does constant (V/f) control mean? Give the relation between ‘V’ and ‘f’ for different speeds. With the help of block diagram, describe its implementation.

3'(c) A 2.8 kW, 400 V, 50 Hz, 4 pole, 1370 rpm, 3-phase Y-connected induction motor has the following parameters referred to stator:

\[ R_s = 1.9 \, \Omega, \quad R_f' = 4.757 \, \Omega, \quad X_s - X_f' = 3 \, \Omega \]

Load characteristics are matched with motor such that the motor runs at 1370 rpm with full voltage across its terminals. The motor is controlled by terminal voltage control and load torque is proportional to speed. Calculate the motor terminal voltage and current at half the rated speed. Can the motor be allowed to run continuously at this speed?

4(a) Give the block-diagram (or the circuit-diagram) for closed-loop control of separately excited dc motor employing both armature control and field control. Briefly explain its operation.

4(b) Give the arrangement for implementation of closed-loop speed control of static Scherbius drive. Explain its operation.

5(a) Mention the advantages of using microprocessor in electric drives.

5(b) What are the functions a microprocessor performs when it is used for closed loop speed control of AC motor?

5(c) Briefly describe the principle of working of phase-locked loop. How it can be used for closed loop speed control of DC motor?
**2012-13**  
**B.TECH. (WINTER SEMESTER) EXAMINATION**  
**ELECTRICAL ENGINEERING**  
**POWER SEMICONDUCTOR CONTROLLERS**  
**EE 422**  

Maximum Marks: 60  
Credits: 04  
Duration: Three Hours

*Answer all the questions. Use graph paper or waveform exercise sheets for showing three-phase waveforms.*

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>For power electronic circuits, why an RLC (under-damped) circuits can be analysed as an LC (un damped) circuit? Explain with the help of waveform and current response equations.</td>
<td>04</td>
</tr>
<tr>
<td>1(b)</td>
<td>An ac-to-dc controlled rectifier or a battery charger circuit (RLET type) is operating in discontinuous current mode. Find the expressions for: (i) the minimum and maximum switching angle (α), and (ii) the load current (charging current).</td>
<td>08</td>
</tr>
</tbody>
</table>

**OR**

1'(a) Describe merits and demerits of simulation software used for power electronic systems.

1'(b) Show that the energy storage capability of an inductor depends upon the air-gap of its core. What is the limit of air-gap and why?

2(a) Compare thyristors with power MOSFET and IGBT.

2(b) Why thyristors are connected in series? What arrangements are necessary for it? How a suitable value of capacitor can be selected for this purpose, explain?

**OR**

2'(a) What is significance of thermal resistance? Give a thermal resistance based model of a hockey-puck type thyristor.

2'(b) Describe a procedure for designing heat sinks for power semiconductor devices. | 04   | 08   |
3(a) Why the Off-line UPS is cheaper than On-line UPS? Also compare their performance. What are different energy storing elements used in UPS.

3(b) Describe different arrangements/equipment used as power conditioners to the utility (power supply).

OR

3'(a) Why is the switched mode power supply (SMPS) better than a linear power supply, explain?

3'(b) With the help of waveforms, explain the working of an isolated output, forward (buck) dc-dc converter with a three-winding transformer. What is significance of the third winding?

4(a) With the help of current and voltage trajectories during switching conditions, compare the performance of switched-mode dc-dc converters and resonant converters.

4(b) With the help of waveforms, explain the working of a ZVS based resonant converter.

5(a) Show the applications of power electronic converter in any renewable energy based system.

5(b) Show that the performance of series converter is better than the conventional ac-to-dc converter.
Question

1(a) What are “Load curves” and “Load duration curve.” Discuss their utility in economic generation.

1(b) A consumer has the following connected load:
10 Lamps each of 60 W, 2 Heaters each of 1000 W. Max demand is 1500W. On the average he uses 8 lamps for 5 hours per day, each heater 3 hours per day. Find:

a)- Avg Load, b)- Monthly energy Consumption, c)- Load factor.

OR

1’ Explain the term depreciation and diversity factor? Discuss various methods of calculating depreciation of an electric power plant.

Find the diversity factor of a power station which supplies the following loads:
Load A: Motor Load of 150 kW between 10 A.M. to 7 P.M.
Load B: Lighting Load of 50 kW between 7 P.M. to 11 P.M.
Load C: Pumping Load of 55 kW between 3 P.M. to 10 A.M.

2(a) What is power factor? Enumerate the advantages of improving power factor?

2(b) A 1000 kW turbine generator set (turbine capability of 1250 kW) is already operating at rated load of 1000 KVA, 0.8 pf lagging. An additional load of 170 kW, 0.85 pf lagging is to be added? What KVAR of capacitor is required so that neither the turbine nor the generator will be overloaded?

OR
2'(a) What objectives should a utility keep in mind while deciding the tariffs for consumer? How do demand factor, load factor and diversity factor in a power system affect the fixation of tariffs?

2'(b) What is the effect of power factor on tariff? Discuss.

3 Discuss the advantages of operating a hydro and a thermal plant in coordination?

On the system consisting of two generating plants (thermal & hydro) the incremental costs in rupee per megawatt hour with \( P_1 \) and \( P_2 \) in megawatts are:

\[
\frac{dC_1}{dP_1} = 0.15P_1 + 150; \\
\frac{dC_2}{dP_2} = 0.25P_2 + 175;
\]

The system is operating on economic dispatch with \( P_1 = P_2 = 200 \text{ MW} \) and \( \frac{\partial P_L}{\partial P_2} = 0.2 \). Find the penalty factor of plant 1.

OR

3' Discuss the suitability of steam and hydro plants as base load and peak load plants.

The daily load curve data for a certain area is as under:

<table>
<thead>
<tr>
<th>Time</th>
<th>12-5 am</th>
<th>5-8 am</th>
<th>8-12 noon</th>
<th>12-1 pm</th>
<th>1-5 pm</th>
<th>5-9 pm</th>
<th>9-12 night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load</td>
<td>100</td>
<td>150</td>
<td>250</td>
<td>100</td>
<td>250</td>
<td>350</td>
<td>150</td>
</tr>
<tr>
<td>MW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It is proposed to install a run off river plant and a steam plant for supplying the above load. The run off data indicates that a flow of 50 m\(^3\)/sec is available for 97% of the time during the Year. The head is 100m, hydro plant efficiency is 90% and transmission losses 8%. Determine the capacity of hydro plant and steam plant. Also suggest a schedule of plant output.

4 Mention the advantages of static excitation system. Explain the construction and working of brushless excitation system used for alternators with the diagram.

5(a) Explain the need and advantages of EHV system?

5(b) Explain (in short) the working of SCADA?

5(c) Explain why earthing of substation necessary? Write the procedure to prepare an earthing mat.
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Answer all the questions.  
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Q 1(a) Differentiate between
1. Cascade control and Ratio control
2. Floating control and Integral control
3. Feed Back and Feed forward control

[06]

1(b) For the error shown in Fig.1. Find the output of a PID controller and show it graphically, if \( K_p = 4, \ K_D = 0.7, \ K_I = 0.5, \ P(0) = 20\% \).

[06]

\[
\text{% error} \quad \downarrow \\
\quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad 
\end{align*}

Fig.1

\[
\begin{align*}
\text{Time (Seconds)} \quad \downarrow \\
0 \quad 1 \quad 2 \quad 3 \quad 4
\end{align*}
\]

OR

Contd......2
Q1'(b) A water tank looses heat; the temperature drops down by 1.5 K/min. When the heater is ON the system gains temperature at 6 K/min. A two position controller has a 0.5 min lag and a neutral zone of 6% of the set point about a set point of 323K. Plot heater temperature versus time. Find the oscillation period.

Q2(a) With neat sketch, explain the working of pneumatic PID controller. Mention its advantages and limitations.

(b) Draw a neat sketch of Electrical proportional controller and explain its operation.

OR

Q2'(a) What is the purpose of final control element? Explain the construction and characteristics of different types of control valves.

(b) Find the working force resulting from 250 N applied to a 1.25 cm radius forcing piston in a hydraulic actuator if the working piston has radius of 10 cm. Also calculate the hydraulic pressure.

Q3(a) Discuss the methods of measurement of solid and liquid flow with neat sketch.

(b) With the help of suitable diagram, explain various temperature transducers used in process industry. Mention specific application of each transducer.

OR

Q3'(b) A thermocouple gives a voltage proportional to temperature with a sensitivity of 5 mV/°C. The sensor has an output resistance of 2.0 KΩ. If the sensor is connected to an amplifier with input resistance of 5 KΩ and gain of 200, find the amplifier output for a temperature of 100 °C.

(a) neglecting loading effects

(b) considering loading effects.
Q4(a) Explain direct digital control and computer supervisory control and mention their advantages and limitations.

(b) What does tuning a control system mean? What are different tuning methods for feedback control system? Explain ultimate cycle method.

OR

Q4*(a) With the help of suitable example, explain Frequency response method of tuning a controller.

(b) A process is to be tuned by transient response to quarter amplitude using PID controller. The system control temperature varies from 140 °C to 300°C with 220°C set point. The output is heater control voltage ranging from 0 to 24 volts. The test is started with the system having 14 volt output. The output is increased suddenly to 16.5 volts. The resulting temperature graph is shown in Fig.2. Find the proper PID gain setting with and without quarter amplitude criteria.

![Graph showing temperature over time](image)

Fig.2

Q5(a) What is PLC? Discuss its architecture and explain the function of each part.

(b) What are various applications of PLC? Explain any one application with the help of suitable ladder logic diagram