TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE 702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the advantages of electrical energy over other forms of energy? Also write how electrical energy needs to be utilized in order to achieve development in our country? [8]

   b) What are the advantages of electric heating? Discuss the methods of temperature control of resistance ovens. [8]

2. a) A motor drives two loads, one has a rotational motion. It is coupled to a motor through a reduction gear with a=0.1 and efficiency of 92%. The load has moment of inertia of 10 kgm^2 and torque of 12N-m. The other load has a translational motion and consists of thousand kilograms to be lifted up at a uniform speed of 1.5 m/s. Coupling between this load and motor has an efficiency of 80%. Motor has inertia of 0.2 kgm^2 and runs at a constant speed of 1420 rpm. Determine equivalent inertia referred to the motor shaft and power developed by the motor. [6]

   b) What are the various components of friction torque? Show how the friction torque components vary with speed with the help of speed-torque graph. [6]

   c) Explain the classes of motor duty with respect to continuous duty, short time duty and intermittent duty. [4]

3. a) A 220V dc shunt motor takes 22A at rated voltage and runs at 1000 rpm. Its field resistance is 100 ohm and armature circuit resistance is 0.1 ohm. Compare the value of additional resistance required in the armature circuit to reduce the speed to 800 rpm when
   (i) the load torque is proportional to speed,
   (ii) the load torque varies as the square of the speed. [8]

   b) What is slip power recovery scheme? Describe in detail about slip power recovery scheme using static Scherbius drive and static Kramer drive. [8]

4. a) What type of train service correspond to trapezoidal and quadrilateral speed time curve? [5]

   b) What are the main requirements of an ideal traction system? [5]

   c) An electric locomotive is accelerated and retarded at 0.8 kmphs and 3.2 kmphs respectively. If the ratio of maximum to average speed is 2 and time of stop is 30 seconds. Find scheduled speed for the run of 3 km assuming trapezoidal speed time curve. [6]

5. a) Why is customer acceptance important in implementation of demand side management? How can it be achieved? [8]

   b) A 3ϕ induction motor has pf 0.9 and efficiency of 0.9 at full load, power factor 0.5 and efficiency 0.8 at half full load. At no load the current is 25% of full load current and power factor 0.1. Capacitors are supplied to make the line power factor 0.8 at half full load. With those capcitors connected find line power factor at full load and no load. Also find the cost of electricity use for a month at no load assuming the machine operates for 80% of time. Tarrif: Rs. 200 of max kVA per month plus 50 paisa per kWh. [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE 702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) How electrical consumers are classified, discuss about their demand characteristics. Also state how these classification differs according to countries? [8]

   b) What are the characteristics of heating element? Explain the design of heating element in resistance heating. [8]

2. a) State the methods of power transfer. Compare flat belt drive and V belt drive. [4]

   b) What are the classes duties to be performed by the motor on the basis of load variations? Give examples of each. [4]

   c) A 230V, 25kW d.c. shunt motor running at its rated speed of 1500 rpm is to be braked by reverse current braking. The armature resistance is 0.1 ohm and the rated efficiency of the motor is 88 percent. Calculate

   (i) the resistance to be connected in series with the armature to limit the initial braking current to twice the rated current,
   (ii) the initial braking torque and
   (iii)the torque when the speed of the motor falls to 600 rpm. [8]

3. a) Explain ward-Leonard system of speed control with diagram. Also state the advantages and disadvantages of this method. [8]

   b) A star-connected induction motor has the following data:
   440V, 50 Hz, 4-pole, 1460 rpm, Rs = 2 ohm, $R_r' = 2$ ohm, $X_s = X_r' = 3$ ohm
   Calculate the starting torque and the starting current of this motor at 50 Hz and 10 Hz for v/f control. [8]

4. a) What do you mean by electrical traction system? Compare the features of at least three electrical traction locomotives. [6]

   b) Define average speed, crest speed and schedule speed and discuss the factor affecting schedule speed of train. [4]

   c) The schedule speed of an electric train with stations 777m apart is 27.3 km per hour and the maximum speed is 20% higher than average running speed. The braking rate is 3.22 kmphps and the duration of stop is 20s. Find the acceleration required. Assume simplified speed time curve with free running at the maximum speed. [6]

5. a) What is importance of Load Management? What are the technique to manage demand side in an effective way? Explain in detail. [8]

   b) The load on a certain industrial premises is about 1200 kVA @ 0.75 lagging power factor for 3,000 hours per annum. The Tariff is Rs 1,300 per kVA maximum demand plus 80 paisa per kWh. Determine annual charge of energy. also if a power factor improving apparatus is installed to improve the power factor to 0.95 lagging. Determine the kvar required and the new annual charge of energy if the power factor improving apparatus costs Rs 1200 per kvar, annual interest and depreciation charges are 10% of the capital cost. [8]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE 702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *The figures in the margin indicate <u>Full Marks</u>.*
- ✓ *Assume suitable data if necessary.*

1. a) Elaborate the role of electrical energy in the sustainable development of the country. Describe on the basis of the utilization of the electrical energy. [8]

   b) A household water tank having cubical structure has the surface area of $6m^2$ and if filled to 90% capacity six times daily. The water is heated from 20°C to 65°C. The losses per square meter of tank surface is 6.3 W/°C. Find the loading in kW and the efficiency of the tank. Assume specific heat of water = 4,200 J/kg/°C and 1kWh = 3.6MJ, $1m^3$ of water = 1000 kg. [8]

2. a) A horizontal belt conveyor moving at a uniform speed of 0.9 m/s transports material at 95 tons/hour. Belt is 180 m long and is driven by motor at 1500 rpm.

   (i) Find load inertial to motor shaft,
   (ii) Find the torque of motor to accelerate the belt from stand still to fall speed in 6 seconds. Moment of inertia of motor is 0.15 Kg/m^2. [8]

   b) A 25 H.P., 220 V DC shunt motor with a full load speed of 600 rpm is to be braked by plugging. Estimate the value of resistance which should be placed in series with it to limit the current to 130 A. what should be the initial value of the electrical breaking torque and value when speed has fallen to half of its full load value? Armature resistance- 0.1 Ω. Full load armature current = 95A. [8]

3. a) The speed of the separately excited dc motor is controlled by a single phase full controlled bridge rectifier with the field also being controlled by the full converter. The field current is set to maximum possible value. The supply voltage to the armature and field converters are 220 V, 50 Hz. the armature resistance and field resistance are 0.2 Ω and 150 Ω respectively. The motor voltage constant, $K' = 1.1(V/A).(rad/s)$. The armature current corresponding to the load demand is 25 A. Assume that the armature and field currents are continuous and ripple free and no-load losses are negligible. If the delay angle of the armature converter is $\alpha = 45°$ and armature current is 25 A. Determine:
   (i) The torque developed by the motor
   (ii) The speed of the motor and
   (iii)The power factor of the drive [8]

   b) How can slip power loss to be recovered by Kramer's System and Scherbius System? [8]

4. a) Explain the requirements of the Ideal Traction System. Explain Self Contained Vehicle with its various transmission systems. [6]

   b) Draw speed time curves for urban, sub-urban and main line services. Compare their characteristics. [4]

   c) An electric train is to have acceleration and braking retardation of 0.7 km/h/s and 3.2 km/h/s respectively. If the ratio of maximum to average speed is 1.4 and time for stops is 25 seconds, find the schedule speed for a run of 1.5km. Assume simplified trapezoidal speed-time curve. [6]

5. a) What do you mean by electrical tariff? What are different types of electrical tariff used in our country? Also write why NEA (Nepal Electricity Authority) impose such tariffs to its consumers? [8]

b) A 340 kW, 50 Hz, 3- phase star connected induction motor has full load efficiency of 85% and p.f of 0.8 lagging. It is desired to improve the power factor to 0.96 lagging by using bank of three capacitors. Calculate:
(i) The kVAR rating of the capacitor bank.
(ii) The capacitance of each limbs of the condenser bank connected in delta.
(iii)The capacitance of each capacitor, if each one of the limb of the delta – connected condenser bank is formed by using 6 similar 3300 V capacitors. [8]

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13 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) "Proper utilization of electrical energy can lead to sustainable development of country". Justify with reference to present and past scenario of Nepal. [4]

   b) According to energy utility in your area, classify and explain different types of electrical consumer. [4]

   c) A 2.5 kW, 240 V, single phase resistance oven is to have nichrome wire heating elements. If the wire temperature is to be 1500°C and that of the charge 450°C, estimate the diameter and length of the wire. The resistivity of nichrome alloy is 42.5 μΩ-cm. Assume radiating efficiency and the emissivity of the element 1.0 and 0.9 respectively. [8]

2. a) A motor drives the loads, one through gear and the second through belt. The inertia of the motor is 0.3 kg-m^2, inertia of gear driven load is 15 kg-m^2, gear speed reduction ratio is 0.1, inertia of belt driven load is 0.6 kg-m^2, diameter of driver pulley is 10 cm and diameter of driven pulley is 30cm. The motor speed is 1440 rpm. Find the equivalent inertia, referred to motor shaft and torque and power of motor. Torque of loads are 100 N-m and 35 N-m. Neglect loss. [8]

   b) Explain with necessary diagram the difference between plugging, dynamic breaking and regenerative braking with d.s shunt motor. [8]

3. a) Explain with help of diagram how the speed of a single phase separately excited d.c drive is controlled using a full converter. [8]

   b) A 400 V 4 pole 50 Hz3 phase star connected induction motor has the following parameters: number of stator turns/phase is twice the number of rotor turns/phase. $R_1 = 0.64\ \Omega$, $X_1 = 1.1\ \Omega$, $R_2 = 0.08\ \Omega$ and $X_2 = 0.12\ \Omega$. The load torque is proportional to the square of speed and is 40N-m at 1440 rpm. If the motor speed is 1300 rpm, find (a) load torque (b) rotor current (c) stator applied voltage. Neglect no load current. [8]

4. a) What is electric traction? What are their types? Explain self-contained electric vehicle with its transmission systems and mechanical systems. [6]

   b) Discuss and compare various arrangement of current collection used in electric traction. [4]

   c) Find the schedule speed of an electric train for a run of 1.5 km if the ratio of its maximum to average speed is 1.25. It has a braking retardation of 3.6 km/h/s, acceleration of 1.8 km/h/s and stop time of 21 second. Assume trapezoidal speed/time curve. [6]

5. a) Explain about the current tariff structure of Nepal Electricity Authority for domestic load. [4]

b) What is Demand Side Management (DSM)? Explain about different types of load priority techniques in DSM. [1+3]

c) A 600kW, 50Hz, 400V, 3-phase load has power factor of 0.8 lagging. It is desired to improve the power factor to 0.95 lagging by using a delta-connected bank of 2200V capacitors. Calculate: [8]

i) Capacitance of each capacitor

ii) kVA rating of capacitor bank and transfomer

iii) Percentage reduction in the line losses.

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13 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the advantages of electrical energy over other forms of energy? Also discuss different types of electrical consumer on basis application and end use. [8]

   b) What are the factors which limit the choice of high frequency in induction and dielectric heating? Calculate KVA and KW drawn from supply, its p.f. and electrical efficiency with the following data pertaining to an electric arc furnace three phase. Current drawn = 4500 A, arc voltage = 50 V, resistance of transformer referred to secondary = 0.002 ohms and reactance of transformer referred to secondary = 0.004 ohms. [4+4]

2. a) Explain 4-quadrant operation of a dc motor with help of loaded and unloaded cage. [8]

   b) A 550 V, 45kW, 600 rpm dc shunt motor has a full load efficiency of 90%. The field resistance is 200 Ω and armature resistance is 0.2 Ω. Find the speed under each of the following conditions at which will develop an electromagnetic torque equal to the related value: [8]

      i) Regenerative braking with no limiting resistance
      ii) Plugging with external limiting resistance of 5.5 Ω inserted.
      iii) Dynamic braking with external limiting resistance of 2.6 Ω inserted. The field current is maintained constant and armature reaction and brush drop may be neglected.

3. a) A 500 V, 1500 rpm, 100 A separately excited motor is fed from a 350 V, 3-phase supply through a 3-phase. Semi-controlled bridge converter. Armature resistance is 1.1 ohm. If firing angle is 45° find rms source current, rms thyristor current, and average thyristor current and power factor at input terminals. Assume constant armature current and speed of 1200 rpm. [8]

   b) What do you mean by slip power recovery system? Explain in detail the different methods of slip power recovery. [8]

4. a) Why tramways are losing ground to other system of traction? And what is the scope of application of battery drive? [4]

   b) A train runs between two stations 2 KM apart at an average speed of 40km/hr. The run is to be made according to simplified quadrilateral speed-time curve. If the maximum speed to be limited to 80 km/hr, acceleration to 2 km/hr/s, coasting retardation to 0.15 km/hr/s and braking retardation 3 km/hr/s. Determine the duration of acceleration, coasting and branking periods. [8]

   c) Explain how actual speed-time curve for an electric train service can be replaced by a curve having a simple geometric shape. What type of train services corresponds to trapezoidal and quadrilateral speed time curves? [2+2]

5. a) What are the importance of demand side management? Explain its objectives for effective demand side management. [4]

   b) What is two part tariff? Compare it with power factor tariff. [4]

   c) A 35 kW induction motor has p.f.0.9 and efficiency 0.9 at full load, power factor 0.6 and efficiency 0.7 at half load. At no-load the current is 25% of full-load current and power factor 0.1. Capacitor are supplied to make the line power factor 0.8 at half full-load. With these capacitor in the circuit, find the power factor at (i) full load and (ii) no load. [8]

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13 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
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Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ ***All** questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Classify and explain different types of electrical consumers on the basis of voltage level.
   b) What are the factors to be considered for electric heating in building design?
2. a) What do you mean by electric drive? Compare between individual, group and multi-motor drives with applications.
   b) A horizontal conveyer belt moving at uniform speed of 2.2 m/s transports material at the rate of 200 tones/hour. Belt is 100m long and driven by a motor at 1500 rpm.
      (i) Determine load inertia referred to motor shaft.
      (ii) Calculate torque that motor should develop to accelerate the belt from standstill to full speed in 8 sec. Moment of Inertia of motor is 0.1 kg-m^2.
3. a) Explain Ward-Leonard type variable speed drives enlisting its major benefits and dis benefits.
   b) A 8-pole 25 Hz 3 phase induction motor is running at 4% slip when delivering full load torque. It has standstill rotor resistance of 0.1 Ω and reactance 0.6 / phase. Calculate the speed of motor if additional resistance of 0.5 Ω / phase is used.
4. a) What do you mean by electric traction? Draw the speed-time curve for urban, sub-urban and main line services explaining the following terms: Free run period, Coasting Period.
   b) A train runs between 2 stations 2 km apart at an average speed of 40 km/hr. The run is to be made according to simplified quadrilateral speed-time curve. If the maximum speed is to be limited to 60 km/hour, acceleration to 2 km/h/sec, coasting retardation to 0.15 km/h/sec and braking retardation 3 km/h/sec, determine the duration of acceleration, coasting and braking periods.
5. a) What are the causes and disadvantages of low power factor? Briefly describe the differences between static capacitors and synchronous capacitors used for improving power factor of a machine.
   b) The load on an installation is 600 kW, 0.8 lagging which works for 2000 hours per annum. The tariff is Rs 80 per kVA plus 20 paisa per kWh. If the power factor is to be improved to 0.9 lagging by the means of capacitors costing Rs.50 per kVAR, find the annual saving. Allow 10% per annum for interest and depreciation on capacitors.

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13 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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- ✓ *Assume suitable data if necessary.*

1. a) Discuss the role of electrical energy in modern society? [8]

   b) State the various advantages of induction heating. Explain with the help of neat sketch the working of an induction furnace. What is its field of application? [8]

2. a) Draw and explain the control circuit for a multimotor drive. [6]

   b) What factors govern the selection of a motor for particular application? [4]

   c) A separately excited dc motor with the following parameters: R_a = 0.5 Ω, L_a = 0.003H, and K_b = 0.8 V/rad/sec, is driving a load of J = 0.0167kg-m^2, B_l = 0.01 N-m/rad/sec with a load torque of 100 N-m. Its armature is connected to a dc supply voltage of 220 V and is given the rated field current. Find the speed of the motor. [6]

3. a) Explain static Ward-Leonard control scheme for four quadrant control of separately excited motor. Discuss non circulating and circulating current schemes. Mention its merits over conventional Ward-Leonard control. [8]

   b) A 400 V 4 pole 50 Hz 3-phase star connected induction motor has the following parameters: number of stator turns/phase is twice the number of rotor turns/phase, R_1 = 0.64 Ω, X_1 = 1.1 Ω, R_2 = 0.8 Ω, X_2 = 0.12 Ω. The load torque is proportional to square of speed and is 40 N-, at 1440 rpm. If the motor speed is 1300 rpm, find (i) load torque, (ii) rotor current, (iii) stator applied voltage. Neglect no load current. [8]

4. a) What are the merits and demerits of d.c. system of track electrification? [6]

   b) What types of train service correspond to trapezoidal and quadrilateral speed time curves? [4]

   c) A train runs an average speed of 50 km/hr between stations situated 2.5 km apart. Train accelerates at 2 km/hr and retards at 3 km/hr. Find its maximum speed assuming simplified trapezoidal speed time curve. Draw the speed time curve for the run and calculate also the distance travelled by it before the brakes applied. [6]

5. a) Discuss the benefits of Demand Side Management. How does energy efficiency differ from demand side management? [8]

   b) A factory works for 2 shift (8 hours per shift) a day for 285 days in a year. The following two system of tariff are available. (i) Medium voltage supply at Rs 12 per unit plus Rs 1300 per month per kVA of maximum demand. (ii) Low voltage supply at Rs.650 per month per kVA of maximum demand plus Rs.13 per unit. The factory has an average load of 250 kW at 0.8 power factor and a maximum demand of 300 kW at the same power factor. The high voltage equipment costs Rs. 700 per kVA and losses can be taken as 5%. Interest and depreciation charges are 10%. Calculate the difference in the annual cost between the two systems. [8]

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15 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ ***All** questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) What do you mean by electrical energy? Explain the different class of electrical consumers and their demand.

   b) A low frequency induction furnace operating at 10V in the secondary circuit takes 500kW at 0.5 p.f when the hearth is full. If the secondary voltage be maintained at 10V, estimate the power absorbed and the p.f when the hearth is half full. Assume the resistance of the secondary circuit to be thereby halved and the reactance to remain the same.

2. a) A 30 kW, 220V, dc shunt motor with a full load speed of 535 rev/min is to be braked by plugging. Estimate the value of resistance which should be placed in series with it to limit the initial braking current to 200A. What would be the initial value of the electric braking torque and the value when the speed has fallen to half its full load value? (Given: armature resistance of motor = 0.086 Ω, Full load armature current = 150A)

   b) For the selection of various types of motor, what are the classes of duties to be performed by the motor on the basis of load variations? List out some examples of driver/machine applicable to various classes of duties.

3. a) How three phase induction motor has controlled by variable frequency method? Explain with necessary mathematical relation and figures.

   b) A separately excited dc motor is fed from a three phase six pulse fully controlled bridge converter. The motor develops its full load torque at a rated speed of 1800 rpm taking a current of 60 A from a 400 V supply. Determine the rms value of supply voltage if the motor runs at its rated conditions for $\alpha = 0$. What is the range of firing angles for a speed control of 1800 rpm to 900 rpm. The armature resistance is 0.5 ohm. The supply and thyristors are ideal.

4. a) An electric train is to have accleration and braking retardation of 1.2 km/h/s and 3.8km/h/s respectively. If the ratio of maximum to average speed is 1.6 and time for stop 45 seconds, find the schedule speed from a run of 2.5 km. Assume simplified trapezoidal speed time curve.

   b) What is self-contained electric vehicle? What are transmission system employed in these types of electric vehicle? Explain.

5. a) What is demand side management? Explain the effective techniques for effective demand side management.

   b) A 50 Hz HP induction motor has power factor 0.9 and efficiency 90% at full load, power factor 0.6 and efficiency 70% at half load. At no-load the current is 25% of the full-load current and power factor 0.1. Capacitors are supplied to make the line power factor 0.8 at half load. With these capacitors in circuit, find the line power factor at (i) full-load and (ii) no-load

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12/24

13 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
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1. a) What are the micro and macro factors hindering possible generation of electricity in Nepal. [8]
   b) A laminated wooden board 0.3 m long by 0.15 m wide and 0.025 m thick is to be heated to 160°C in 10 minutes by dielectric heating employing a frequency of 30MHz. The wood has a specific heat of 1465 $Jkg^{-1}°C^{-1}$, a weight of 575 kg m^{-3}, a permittivity of 5 and power factor of 0.05. Determine the power required, voltage across the work and the current through it during heating process. (Assume process efficiency between 85 and 90%) [8]
2. a) What is an electric drive? Explain the major parts of an electric drives, also state the advantages and disadvantages of electric drives. [6]
   b) Write the difference between group drive and individual drive. [4]
   c) A 200 V, 1000 rpm, 50 A seperately excited dc motor is to be stopped to zero speed by plugging. Armature resistance is 0.2 ohm. Find (i) additional resistance to be connected is series with armature to limit braking current to twice the rated current (ii) braking torque (iii) torque when speed has decreased to zero. Assume that initial speed is 1000 rpm. [6]
3. a) Draw the torque speed-characteristics of an induction motor with constant V/f control for speed variation from very low up to the base speed. Describe an open loop control scheme for induction motor with constant V/f control. [8]
   b) A three phase half controlled thyristor bridge with 400V, 3-phase, 50Hz supply is feeding a separately excited dc motor. Armature resistance is 0.2Ω, armature rated current is 100 A and back emf constant is 0.25 V/rpm. Determine no load speed if no load armature current is 5A and firing angle is 45°. Also determine firing angle to obtain a speed of 1500 rpm at rated current. [8]
4. a) Draw the speed-time curves for urban and suburban and main line service. Also explain the following terms: (i) Notching period (ii) Accelerating period (iii) Free run period (iv) Coasting period (v) Retardation period. [8]
   b) An electric train has a schedule speed of 25kmph between stations 800 m apart. The duration of station stop is 20 seconds, the maximum speed is 20% higher than average running speed and the braking retardation is 3 kmphps. Calculate the rate of acceleration required to operate this service. [8]
5. a) Explain the concept of demand side management. Discuss the steps involved in DSM planning and implementation. [8]
   b) The load on a certain installation may be considered constant at 1200kVA, 0.75 lagging power factor for 3000 hours per annum. The tariff is Rs 65 per kVA of maximum demand plus 2 paisa per kWH. [8]
      i) Determine the annual charge for electrical energy
      ii) Power factor improving apparatus is installed to improve the power factor to 0.95 lagging. Determine the kVAR required and the new annual charge if the power factor improving apparatus costs Rs 60 per kVAR, annual interest and depreciation charges are 10% of the capital cost and the losses in the apparatus are 5% of the kVAR rating.

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13 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ ***All** questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain the common uses of electrical energy on the basis of domestic, commercial and industrial use. Provide features of electric drives with them.

   b) What do you mean by crest speed, average speed and schedule speed? An electric train has an average speed of 42Kmph on a level track between stops 1400m apart. It is accelerated at 1.7Kmphps and braked at 3.3Kmphps. Draw speed time curve for the run.

2. a) Write the electrical and mechanical characteristics to be considered for selection of motor. Explain Rheostatic braking and Regenerative braking.

   b) A motor running at speed N rpm driving a rotational load L_1 directly coupled to its shaft and another load L_2 through a gear to reduce its speed by a factor K. The inertia of motor, loads L_1, loads L_2 are Jm, J_1, J_2 respectively. The load torque of L_1, and L_2 are T_1 and T_2. Find the expression for total inertia and T reflected to motor. If "T_e" is the electrical torque, what will be the dynamic equation for the motor speed?

3. a) A single phase, 220 V, 50 Hz supply feeds a separately excited dc motor through two single phase semi-converters, one for the field and another for armature. The firing angle of the field semi-converter is zero, the field resistance is 250 Ω and armature resistance is 0.2 Ω. The load torque is 50 N-m at 1000 rpm. The voltage constant is 0.8 V/A-rad/s and the torque constant is 0.8 Nm/A^2. Assuming armature and field currents to be continuous and neglecting losses. Determine:

      i) Field current
      ii) Firing of the converter in the armature circuit
      iii) Power factor of the converter of the armature circuit

   b) Discuss the operation of open loop V/F control of inverter fed induction machine drive. What are problem with it? How do you overcome this effect by closed loop operation, explain it with closed loop block diagram.

4. a) Explain the common methods of electric braking employed in ac and dc drives for traction.

   b) What is demand side management? Explain the effective techniques for effective demand side management.

5. a) A 340kW, 3300V, 50Hz, 3-Phase star connected induction motor has full load efficiency of 85% and power factor of 0.8 lagging. It is desired to improve the power factor to 0.96 lagging by using a bank of three capacitors. Calculate:

      i) The KVA rating of the condenser bank
      ii) The capacitance of each limb of the condenser bank connected in delta
      iii) The capacitance of each capacitor, if each one of the limbs of the delta connected condenser bank is formed by using 6 similar 3300V capacitors

   b) What are the advantages of electric heating? Explain the building design consideration foe electric heating.

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13 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *All questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the roles of electrical energy to develop a country? Explain the benefits of electrical energy over other form of energy.

   b) The following data related to a 3 phase arc furnace:

Quantity of steel to be melted in one hour = 4.3 tonnes
Specific heat of steel = 0.5 kJ / kg
Latent heat of steel = 37.2 kJ/ kg
Melting point of steel = 1370°C
Initial temperature of steel = 19.1°C
Overall efficiency of steel = 50%
Input Current = 5700 A
Resistance of temperature referred to secondary = 0.008 Ω
Reactance of temperature referred to secondary = 0.014 Ω
Determine the following: (i) Average kW input to the furnace, (ii)Arc voltage (iii) Arc resistance (iv) power factor of the current drawn from the supply, and (v) Average kVA input to the furnace.

2. a)

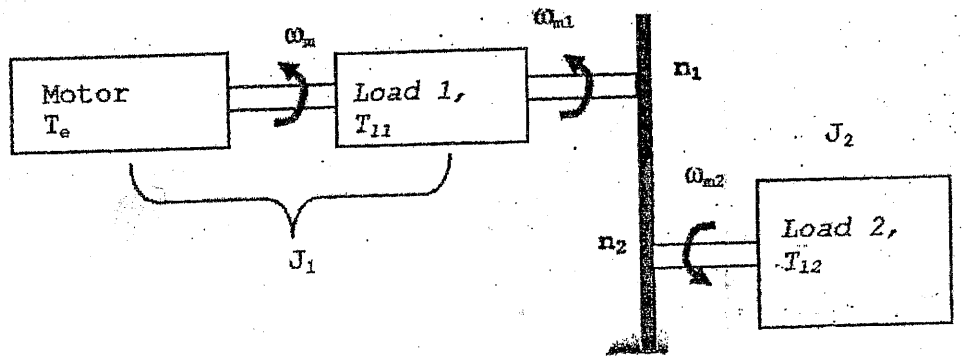

Fig.1a

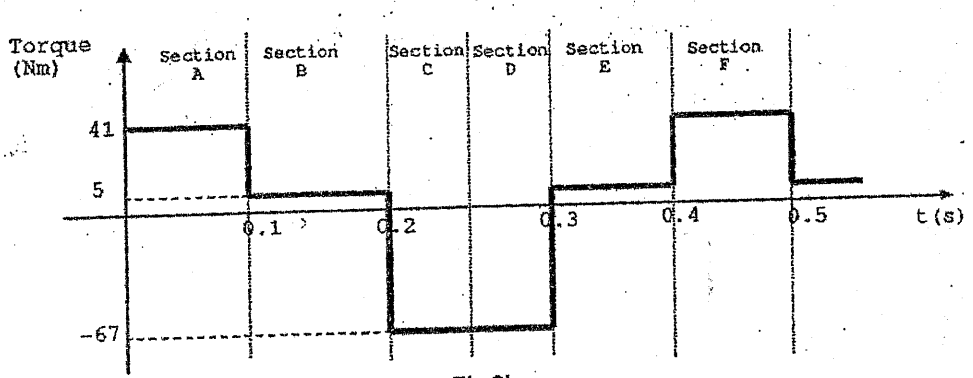

Fig 2b

Consider a dc motor driving system (Figure 1a) with following parameter; J_2=0.01 kg/m^2, n1/n2=2, ; J_1=0.08. Determine the equivalent 'J_{eq}' of the system. If electric torque profile of figure 2b is applied to motor, construct the profile of the speed (Assume Load torque T_L=5 NM). Using the plots (T vs. t and ω vs. t), discuss the quadrant of operation in each section A to F as shown.

b) A 220 V separately excited motor running at 1000 rpm draws 100 A from the source. The motor is braked by plugging. Calculate (i) Resistance to be inserted in the armture circuit to limit the braking current to twice the full load current, (ii) Initial braking torque, (iii) The braking torque when speed has reduced to 500 rpm.

3.a) Discuss the operation principle of two quadrant operation of armature controlled dc motor drive in open loop made. What are the limitation of open loop operation? Draw a closed loop control scheme that over comes the limitations.

b) A 400 V, 50 Hz, 4 pole, 1350 rpm, star connected induction motor is driving a load whose torque varies as square of speed. The motor is controlled by controlling stater voltage. Find the torque and the applied voltage at speed 900 rpm. [Use R_s = 1.5 Ω, R'_r = 4 Ω, X_s = 4 Ω, rotor stand still reactance X'_r = 4 Ω]

4. a) A train runs between the two stations 2 KM apart at an average speed of 40 km/h. The run is to be made according to simplified quadrilateral speed-time curve. If the maximum speed to be limited to 60 km/h, acceleration to 2 km/h/s, coasting retardation to 0.15 km/h/s and braking retardation 3 km/h/s. Determine the duration of acceleration, coasting and braking periods.

b) Describe Speed-time curve for the traction system with suitable example describing all its parts. Describe speed-time curve of urban and sub-urban services.

5. a) What is the role of load management in demand side management? Discuss each of the steps to implement demand side management.

b) A factory takes a load of 200kW at 0.85 pf lagging for 2500 hrs per annum. The tariff is Rs. 150 per KVA plus 5 paisa per KWH consumed. If the pf is improved to 0.9 lagging by means of capacitors costing Rs 420 per KVAR and having a power loss of 100W per KVA, Calculate the annual saving effected by their use. Allow 10% per annum for interest and depreciation.

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15 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *All questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss the roles and advantages of electrical energy over other forms of energy on different applications.
   b) Discuss the various factors to be considered for electric heating in building design.
2. a) For the selection of various types of motor, what are the classes duties to be performed by the motor on the basis of load variations? List out some examples of driver/machine applicable to various classes of duties.
   b) A motor is used to drive a hoist. Motor characteristics are given by:

   Quadrants I, II and IV : T = 200 - 0.2 N N-m

   Quadrants II, III and IV : T = -200 - 0.2N N-m

   Where N is the speed in rpm

   When hoist is the loaded the net load torque T_l = 100 N-m and when it is unloaded, net load torque T_l = -80 Nm obtain the equilibrium speeds for operation in all the four quadrants.
3. a) With the help of mathematical expression and block diagrams discuss the PID control of speed and torque of electric motor?
   b) Discuss the slip power recovery system for slip ring induction motor.
4. a) The schedule speed with a 200 tonne train on an electric railway with stations 777 meters apart is 27.2 km per hour and the maximum speed is 20% higher than the average running speed. The braking rate is 3.22 km p.h.p.s and the duration of stop is 20 seconds. Find the acceleration required. Assume a simplified speed-time curve with free running at the maximum speed.
   b) Discuss the applications of different types of motor used in electric fraction with their characteristics.
5. a) What is demand side management? Discuss the effective demand side management technique.
   b) What is tariff? Explain the various forces of tariff with their merit and demerits.

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15 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ ***All** questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain the classification of electrical consumers and their demand.
   b) Compare dielectric heating, infrared heating and microwave heating.
2. a) Compare individual group and multi-motor drive system.
   b) A horizontal conveyer belt moving at a uniform speed of 1.2 m/s transports material at the rate of 100 tonnes/hrs. Belt is 200 m long and driven by a motor at 1200 rpm.
      i) Determine the load inertia referred to the motor shaft
      ii) Calculate the torque that motor should develop to accelerate the belt from standstill to full speed in 8 sec. Moment of inertia of the motor is 0.1 kg-m^2.
3. a) A dc chopper fed from 400 v supply runs a separately excited motor. The armature resistance is 0.1Ω. The motor voltage constant is 4 V-s/rad, the average armature current Ia = 150 A. The armature current is continuous and has negligible ripple. Determine (i) the input power (ii) the motor speed (iii) the developed torque for a duty cycle of 60%, Neglect the losses in chopper. If the duty cycle of the chopper varies between 10% and 90%, find the minimum and maximum speeds.
   b) What happen if an induction motor is started with variable frequency? What is the technique to overcome the problems associated with variable frequency? Justify your answer with suitable mathematical expression.
4. a) What is self contained electric vehicle? What are the transmission systems employed in these types of electric vehicle? Explain.
   b) Compare the characteristics of various system of electrification for traction purpose.
5. a) Why demand side management is necessary? What are the techniques to manage demand side in an effective way? Explain in detail.
   b) A 35 KW induction motor has power factor 0.9 and efficiency 0.9 at full load, power factor 0.6 and efficiency 0.7 at half load. At no load the current is 25% of full load current and power factor 0.1. Capacitors are supplied to make the line power factor 0.8 at half load with these capacitors in circuit, find the line power factor at (i) full load and (ii) no load.

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15 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt <u>All</u> questions.*
- ✓ *<u>All</u> questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss the advantages of electrical energy over other forms of energy on different applications.

   b) A 30 KW, 3 phase, 400 V resistance oven is to employ nickel- chrome strip 0.025 cm thick for a 3 phase star connected heating elements. If the wire temperature is to be 1100°C and that of charge is to be 700°C, estimate a suitable width for the strip. Assume radiating efficiency as 0.6 and emissivity as 0.9. The specific resistance of the nichrome- alloy is 10.3×10-6 Ωm. State any assumption made.

2. a) Discuss the various components of load torque that has to be considered for the mechanical characteristics matching. Also mention some examples of these load torques based on particular applications.

   b) A weight of 500 kg is being lifted up at a uniform speed of 1.5 m/s by a winch which is driven with the help of motor running at a speed of 1000 rpm. The moment of inertia of the motor and winch are 0.5 and 0.3 kg-m^2 respectively. Calculate the motor torque and the equivalent moment of inertia referred to the motor shaft. In the absence of weight, motor develops a torque of 100 N-m when running at 1000 rpm.

3. a) Developing the over all block diagram of dc motor, discuss the PID control for speed and torque control of DC motor.

   b) Starting from Volt/Hz control of three phase induction motors. Discuss their frequency control schemes.

4. a) What is the schedule speed of a traction system? Discuss the various factors affecting this speed.

   b) A train has schedule speed of 60 km per hour between the stops which are 6 km apart. Determine the crest speed over the run assuming trapezoidal speed curve. The train accelerates at 2 km per hour per sec and retards at 3 km per hour per sec. Duration of stops in 60 second.

5. a) What is demand side management? Explain the various schemes adopted for the demand side management.

   b) The load on an installation is 800 KW, 0.8 lagging which works for 3000 hours per annum. The tariff is Rs 100 per KVA plus 20 paisa per kwh. If the power factor is improved to 0.9 lagging the means of loss free capacitors costing Rs 60 per KVAR, calculate the annual saving. Allow 10% per annum for interest and depreciation on capacitors.

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15 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL	Pass Marks	32
Year / Part	IV / I	Time	3 hrs.

Subject: - Utilization of Electrical Energy *(EE702)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ ***All** questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss the common use of electrical energy based on domestic, commercial and industrial with suitable examples and their voltage level.
   b) Explain in brief the various methods of electric heating used in industrial and domestic purpose.
2. a) What is electric drive? Discuss the various types of electric drives with their merits and demerits.
   b) Obtain the equilibrium points and determine their steady-state stability when motor and load torque are $T_m = -(1+2w_m)$ and $T_L = -3\sqrt{w_m}$ respectively.
3. a) A three phase half controlled thysistor bridge with 400V, 3-phase, and 50Hz supply is feeding armature terminal of a separately excited dc motor with field terminal fed by constant voltage. Armature resistance is 0.2Ω, armature rated current is 100 A and back emf constant is 0.25V/rpm. Determine no-load speed if no load armature current is 5A and firing angle is 45°. Also determine firing angle to obtain a speed of 1500 rpm at rated current.
   b) Explain the slip power recovery system for slip ring induction motor.
4. a) What is electric traction? Explain the types of electric traction system based on the types of supply source. Also discuss their advantages and disadvantages.
   b) Define speed time curve for traction system. Discuss speed time curve of urban service, sub-urban service and main line service.
5. a) The annual working cost of a power station is represented by the formula Rs (a+b×kw+c×kwh) where the various terms have their usual meaning. Determine the values of a, b and c for a 60 MW station operating at annual load factor of 50% from the following data:
      i) Capital cost of building and equipment is Rs. 5×10^6
      ii) The annual cost of fuel, oil, taxation and wages of operating staff is Rs. 9,00,000.
      iii) The interest and depreciation on building and equipments are 10% per annum
      iv) Annual cost of organization and interest on cost of site etc is Rs.5,00,000.
   b) What are the causes and disadvantages of low power factor? Explain the various techniques to improve power factor.

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