Important suggestions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skills)
4) While assessing figures, examiner may give credit for principle components indicated in a figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case some questions credit may be given by judgment on part of examiner of relevant answer based on candidate understands.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.1 A	**Attempt any THREE of the following :** **12 Marks**
a)	**List out energy conservation techniques to be adopted to reduce losses in the induction motor.**
Ans:	**Following are the list of energy conservation techniques in electrical motors:** **(Any four point expected: 1 Mark each)** 1) Reduction in iron losses by using low loss silicon steel core material laminated to thinner dimension. 2) Using bigger length dimension (longer cores) to increase the area of magnetic flux due to which the flux density is lowered to reduce the eddy currents & hysteresis losses. 3) Lowering the air gap that leads to reduction of the reluctance of the magnetic circuit & hence lower magnetizing current to produce the same flux density. 4) Using low resistance copper bars in rotors instead of high resistance aluminum bars leading to reduction in the copper losses in rotor. 5) Use very smooth surface finishing of stator/rotor (air gap) leading to low windage losses 6) Use high quality bearings to reduce the frictional losses. 7) Use smaller diameter fans to reduce fan load (as above measures lead to lower heat production in motors & hence reduced cooling requirements). 8) By minimizing idle & redundant running. 9) By matching motor rating as per required load. 10) By Phase balancing. 11) By improving power quality. 12) Operating motor in star mode at light load.

A summary of energy efficiency improvements in EEMs is given in the Table 2.2:

TABLE 2.2 ENERGY EFFICIENT MOTORS

Power Loss Area	Efficiency Improvement
1. Iron	Use of thinner gauge, lower loss core steel reduces eddy current losses. Longer core adds more steel to the design, which reduces losses due to lower operating flux densities.
2. Stator I^2R	Use of more copper and larger conductors increases cross sectional area of stator windings. This lowers resistance (R) of the windings and reduces losses due to current flow (I).
3. Rotor I^2R	Use of larger rotor conductor bars increases size of cross section, lowering conductor resistance (R) and losses due to current flow (I).
4. Friction & Windage	Use of low loss fan design reduces losses due to air movement.
5. Stray Load Loss	Use of optimized design and strict quality control procedures minimizes stray load losses.

b) List out the factors to be considered to select electrical drives for an application.

Ans: **Following are the factors to be considered to select electrical drives for an application:**

(Any Four factor are expected: 1 Mark each)

1) Load torque required at normal speed matches with available torque of motor.
2) Break down torque or pull out torque or maximum torque must match with the maximum torque requirement by load.
3) Starting torque of motor must be more than that needed by load.
4) The duty or load cycle of the motor determines the motor's thermal loading; hence it should be such that sufficient time is available for cooling between the cycles.
5) The torque speed characteristics available from the motor must match the requirements of the load.
6) The environment/atmosphere in which the motor is to be installed govern the motor operating characteristics required. Eg. Corrosive atmospheres, dusty atmospheres, high temperature spaces need properly chosen motors for drives.
7) Cost of the motor plays an important role if a range is available.
8) Easily procurable, quick and easily serviceable motors are normally preferred. Standard motors are normally preferred.
9) Normally while selecting motors its performance is verified from the test certificate.
10) The power factor (reactive power drawn) and performance between 70% load to 100% load are considered. A motor having good characteristics in this regards will be always be preferred.
11) If selecting an energy efficient motor the cost benefit analysis over the long run must be worked out.

OR **Following Factors governing / or are considered while selecting electric drive (Motor) for particular application:**

1. **Nature of supply:**

Whether supply available is

- AC,
- Pure DC
- Or Rectified DC

2. **Nature of Drive (Motor):**

Whether motor is used to drive (run)

- Individual machine
- OR group of machines.

3. **Nature of load:**

Whether load required light or heavy starting torque

- OR load having high inertia, requirehigh starting torque for long duration.
- OR Whether load torque increases with speed ($T \alpha N$)
- OR decreases with speed ($T \alpha 1/N$)
- OR remains constant with speed (T = N)
- OR increases with square of speed ($T \alpha N^2$)

4. **Electric Characteristics of drive:**

- Starting,
- Running,
- Speed control
- and braking characteristics

of electric drive should be studied and it should be matched with load requirements(i.e. machine).

5. **Size and rating of motor:**

- Whether motor is short time running
- OR continuously running
- OR intermittently running
- OR used for variable load cycle.

Whether overload capacity, pull out torque is sufficient.

	6. Mechanical Considerations: ➢ Types of enclosure, ➢ Types of bearing, ➢ Transmission of mechanical power, ➢ Noise ➢ and load equalization **7. Cost:** ➢ Capital, ➢ Running ➢ and maintenance cost should be less.
c)	**Why energy conservation techniques should be adopted in transformers even though its efficiency is 90%?**
Ans:	**Reason for energy conservation techniques should be adopted in transformers even though its efficiency is 90% :** **(4 Marks)** ➢ Transformer performance depends on its efficiency. Transformers used in real-time applications suffer from load as well as no load losses. Loss of efficiency reduces transformer performance. Hence, customers should try different types of methods to improve the efficiency of the transformer. ➢ Since transformer is almost connected in circuit for 24hrs. Continuously so it is necessary to reduce the losses. ➢ By different techniques it is possible to improve the efficiency of the transformer more than 90% as there are no mechanical losses.
d)	**Epoxy resin transformers are more suitable in hazardous areas. Give reason.**
Ans:	**Reason for Epoxy resin transformers are more suitable in hazardous areas :** **(Any four point expected: 1 Mark each)** 1. Core used is of CRGO M4-M3 circular size, minimizes leakage reactance and hence core losses will be less. 2. Winding consist of flexible rope of copper instead of rectangular strips or rod. Therefore current carry capacity is more and better cooling effect. 3. Insulation consists of high quality epoxy resin which is capable to withstanding high temperature and also provides minimum clearance as per voltage requirement.

	4. As the transformer is fully encapsulated, routine maintenances is less. 5. As cooling oil is absent the total weight of transformer is less. 6. Due to less weight loading & unloading of the transformer is easy. 7. In the absence of oil there is no need of testing the dielectric strength of oil or no filtration of oil.
Q.1 B)	**Attempt any ONE of the following: 06 Marks**
a)	**List out any six significant features of Indian Electricity Act, 2003.**
Ans:	**Significant features of Energy Conservation Act 2003:** **(Any Six point expected: 1 Mark each)** 1) The Central Government to prepare a National Electricity Policy in consultation with State Governments. 2) Thrust to complete the rural electrification and provide for management of rural distribution by panchayats, Co-operative Societies, non-Government organizations, franchisees etc. 3) Provisions for license free generation and distribution in the rural areas. 4) Generation being delicensed and captive generation being freely permitted. Hydro projects need clearance from the Central Electricity Authority. 5) Transmission utility at the central as well as state level to be government company with responsibility for planned and co-ordinated development of transmission network. 6) Provision for private licensees in transmission and entry in distribution through an independent network. 7) Open access in transmission from the outset. 8) Distribution licensees would be free to undertake generation and generating companies would be free to take up distribution businesses. **OR** 1. **Role of Government:** Central government shall prepare national electricity policy and tariff policy in consultation with state government. Central government shall notify a national policy for rural areas permitting stand alone systems based on renewable energy sources in consultation with state government. 2. **Rural electrification:** Concerned state and central government shall jointly take effort to provide supply of electricity to villages. No requirement of license if a person intends to generate and dis 3. **Generation:** Generation free from licensing captive generation is free from controls.

Clearance of central electricity authority required for hydro projects. Generation from Nonconventional sources/captive generation to be promoted.

4. **Transmission:** There would be transmission utility at the centre and in the states to undertake planning and development of transmission system. Load dispatch to be in the hands of Government company / organization. Load dispatch centre / Transmission utility / Transmission Licensee not to trade in power. Open access to the transmission lines to be provided to distribution licenses, generating companies.
5. **Distribution:** Distribution to be licensed by state electricity regulatory commission. Retail tariff to be determined by the Regulatory commission. Metering made mandatory provision of suspension or revocation of license by Regulatory commission . Open access to distribution to be allowed by SERC in phases.
6. **Regulatory commission / Appe:** commission to be constituted within six months. Provision for Joint Commission by more than one state / UT. Appellate tribunal to hear appeals against orders of CECC/SERC and also to exercise general supervision and control over state and central commissions.
7. **Central Electricity Authority:** CEA to continue as the main technical advisor of Govt. of India / state Government with responsibility of overall planning. CEA to specify technical standards for electrical plants and electrical lines. CEA to specify safety standards.
8. New central law as compared with state Reform / Amendment laws: Provision of state Reform laws not inconsistent with provisions of the new central law will continue to apply in the state. State Government can defer implementation of the new Act by a maximum period of six months.

b) State the stepwise procedure to assess the performance of existing lighting system in a facility.

Ans: **Following the stepwise procedure to assess the performance of existing lighting system in a facility:** **(Each step : 1 Mark each)**

Step I: prepare Inventories lighting system elements roughly as given below.

Device rating, population and use profile					
Sr no	Plant location	Lighting device and ballast type	Rating in watts: lamp and ballast	Population numbers	Operation hours per day

Lighting transformer/rating and population profile:				
Sr no	Plant location	Lighting transformer rating	Installed numbers	Meters installed: V, I, kW, kWh.

	Step II: Use lux meter to measure and note the light levels at different places of work at day time and night time with the lamps put on during measurements. **Step III:** Using portable load analyzer, measure and note the V, I, pf, and power consumed at different input points as lighting transformers, DBs etc. **Step IV:** Compare measured lux values with standard required and classify locations as under lit and over lit. **Step V:** Collect and analyze failure rates of lamps, ballasts, and actual life expectancies from past data. **Step VI:** (optional step for this question not expected) Suggest improvement options based on above study as: ➢ Maximize sunlight use by transparent roofs and other means. ➢ Replacement of existing low efficacy fixtures with those with high ones without compromising the CRI, required lux etc. ➢ Interior re-coloring.] ➢ Modify layout for optimization. ➢ Form/Modify control groups for lights. ➢ Use sensor operated fixtures. ➢ Install control gears or regulators. ➢ Replacement of Lamp ➢ Using separate Transformer ➢ Using light control gears.
Q.2	**Attempt any FOUR of the following : 16 Marks**
a)	**State the significant features of Energy Efficient Motor.**
Ans:	**Significant features of Energy Efficient Motor:** **(Any four point expected: 1 Mark each)** 1. Material used is of high quality. (High flux density & High current density) 2. Due to high quality material luminous used are thin hence core size will be less so that losses will be less. 3. Due to precise air gap between stator and rotor reduces the losses. 4. The starting and running torque is more.

	5. The noise & vibration level is less. 6. Less (negligible) maintenance. 7. Operating temperature with standing capacity is more without any problem.
b)	**Suggest the energy conservation techniques in following cases :** **(i) Motor is running with 70% loaded condition.** **(ii) Motor is continuously loaded at 50%.** **(iii) Motor runs with 30% loaded condition but sometimes rises to 50% loading condition.** **(iv) Motor runs continuously under no-load condition.**
Ans:	**Following are the suggestion the energy conservation techniques in following cases :** **(Each Point : 1 Mark)** **(i) Motor is running with 70% loaded condition:** ➢ Use APFC or IPFC for better power factor improvement. ➢ Use cooling fans for motors. **(ii) Motor is continuously loaded at 50% :** ➢ Convert Delta to Star connection for lightly loaded motors. ➢ Use APFC or IPFC for better power factor improvement. ➢ Use cooling fans for motors. **(iii) Motor runs with 30% loaded condition but sometimes rises to 50% loading condition:** ➢ Convert delta to star connection for lightly loaded motors. ➢ Use APFC or IPFC for better power factor improvement. ➢ Use cooling fans for motors. ➢ If possible use low capacity motor for this above condition. **(iv) Motor runs continuously under no-load condition:** ➢ Convert delta to star connection for lightly loaded motors. ➢ Use APFC or IPFC for better power factor improvement. ➢ Use cooling fans for motors. ➢ If possible use low capacity motor for above condition. ➢ If possible switch off the motor.
c)	**State how 'parallel operation of transformers' helps in energy conservation.**
Ans:	**'Parallel operation of transformers' helps in energy conservation:** **(4 Marks)** The transformers operate near their maximum efficiency at around 70 % to 100 % of their rated loads. For a huge load system drawing highly varying powers at different times supplying from single transformer will be uneconomical and inefficient at low loads. Hence to operate the system at highest efficiencies as much as possible parallel connected transformers are utilized such that at lower power requirements one of those in

	parallel will supply at around its maximum efficiency while the other is switched off thus saving its low load losses. This is done as per the requirements of the loads. When more power is needed the other transformer if of higher rating may be put in service while the first one may be switched off.
d)	**List out the different technical losses that takes place in Transmission and Distribution system.**
Ans:	**Different technical losses that takes place in Transmission and Distribution system:** **(Any four losses expected: 1 Mark each)** 1) Losses due to random growth of sub transmission &distribution system. planned growth/expansion maintains the losses to optimum values as the system conductors and other components are judiciously selected. 2) Losses due to large scale rural electrification through long 11KV & LT lines unbalanced loading 3) Losses due to many stages of transformation. (Large no. of transformers). 4) Un balance loading on three phases 5) Losses due to unsatisfactory reactive power compensation. 6) Losses due to poor quality of equipment used.
e)	**Define the following tariff: • Time-off-day tariff • Peak-off-day tariff. Give one example for each.**
Ans:	**Time-off-day tariff:-** **(2 Mark)** ➢ **In addition to basic tariff** (Maximum Demand Tariff / KVA Maximum Demand Tariff / Load factor tariff also the tariff in which P.F. of industrial consumer is taken into consideration.**)** Consumer has to pay energy consumption charges according to time for which energy is consumed. ➢ TOD energy meter is installed in the consumer premises. ➢ This meter is specially designed to measure energy consumption w.r.t. time. ➢ This type of tariff is such that energy consumption charges/unit are less at during Off-load period ➢ Energy consumption charges/unit are more during PEAK -load period ➢ This type of tariff is introduced to encourage industrial consumers to run their

maximum load during OFF-load period.

Peak-off-day tariff: **(2 Mark)**

- Energy consumption charges/unit are more during PEAK -load period
- This type of tariff is introduced to encourage industrial consumers to run their maximum load during Off-load period.
- **e.g.**

Sr.No	Block	Rate / KWH Rs	Remark
1	8.00 am to 12.00 noon	Rs. 6.00 per unit+0.80 Rs. Per unit	Peak load period
2	12.00 noon to 6.00 pm	Rs. 5.00 per unit+ 0 Rs. Per unit	Base load
3	6.00 pm to 10.00 pm	Rs. 6.00 per unit+ 1.10 Rs. Per unit	Peak load period
4	10.00 pm to 8.00 am	Rs. 5.00 per unit – 1.50 Rs. Per unit	OFF load period

OR

- In this tariff expect TOD metering the timer with energy meter facility is provided in the consumer premises, for the consumers there may be some type load.

e.g:

- Heating, pumping, refrigeration, agriculture load can be made off during peak period. Whenever total connected load on power station is less. The consumers load become ON which is less charged

f) State and explain "power factor tariff'.

Ans: **Power Factor Tariff:-** **(4 Marks)**

In addition to basic tariff (Maximum Demand Tariff / KVA Maximum Demand Tariff / Load factor tariff) **the tariff in which P.F. of industrial consumer is taken into consideration.** Is known as Power Factor Tariff.

- If the P.F. of consumer is less than P.F. declare by Supply Company (say below 0.9 Lag.) than penalty will be charged in energy bill.
- If The P.F. of consumer is more than P.F. declare by Supply Company (say above 0.95lag.) then discount will be given in energy bill.
- As usual consumer has to pay actual energy consumption charges

- Application :-

  This type of tariff is applicable to industrial consumer/H.T/ commercial consumers with contract demand above 80 kw/ 100Kva/107 hp consumer.

- Incentives and Penalties to Power factor tarrif :-

Power factor incentive:- e.g.

Power Factor	Percentage of incentive
0.95	0% of energy bill
Above 0.96	1% of energy bill
Above 0.97	2% of energy bill
Above 0.98	3% of energy bill
Above 0.99	4% of energy bill
At unity P.F.	5% of energy bill

Power factor penalty:- e.g.

Power factor lagging	Percentage of penalty
For 0.90 Power factor lagging	0% of energy bill
For 0.89 Power factor lagging	2% of energy bill
For 0.88 Power factor lagging	3% of energy bill
For 0.87 Power factor lagging	4% of energy bill
For 0.86 Power factor lagging	5% of energy bill
For 0.85 Power factor lagging	6% of energy bill
For 0.84 Power factor lagging	7% of energy bill
For 0.83 Power factor lagging	8% of energy bill
For 0.82 Power factor lagging	9% of energy bill
For 0.81 Power factor lagging	10% of energy bill

Q.3	**Attempt any FOUR of the following :** **16 Marks**
a)	**With example explain how the replacement of lamps in lighting system contributes for energy conservation?**
Ans:	**Replacement of lamps in lighting system contributes for energy conservation:** **(4 Marks)** i. Replacing incandescent lamps by Compact Fluorescent Lamps (CFL's) ii. Replacing conventional fluorescent lamp by energy efficient fluorescent lamp. iii. Replacement of Mercury/Sodium Vapour Lamp by Halides Lamp. iv. Replacing HPMV Lamps by High pressure sodium Vapour Lamp (HPSV) v. Replacing filament lamps on panels by LED. **OR** **Following are the energy efficient lamps for Domestic Installation for replacing Lamps as follows**: i) Replacing incandescent lamps (14 lumens/W) by Compact Fluorescent Lamps (CFL's) (70 to 90 lumens/W) ii) Replacing conventional fluorescent lamp (50 lumens/W) by energy efficient fluorescent lamp (70 to 90 lumens/W) iii) Replacing filament lamps (10 to 15 W) on panels by LEDs (< 1 W). Using LED lights in place of all other lamps above as feasible (in terms of cost)
b)	**List out the energy conservation techniques in Fans.**
Ans:	**Following are energy conservation techniques in Fans** : **(Any four point expected: 1 Mark each)** ➢ Use the electronic regulators instead of conventional regulator. ➢ The fan used at low speed instead of high speed. ➢ Adjust the direction of the ceiling fan so the air blows down. ➢ Make sure to turn your ceiling fan “off “when you leave the home and industry. ➢ or even more energy savings, purchase a ceiling fan that has earned the ENERGY STAR rating, ➢ Whole house fans are large, powerful fans usually 20-48 inches in diameter with a one-quarter to one-half horsepower motor. ➢ Don't forget to properly maintain your electric fan and keep it in good working order.

	➢ When shopping for an electric fan or any other type of home appliance, it's easy to estimate appliance energy consumption by following this formula below: ***Wattage x Hours Used Per Day / 1000 = Daily Kilowatt-hour (kWh) Consumption*** ***(1 kilowatt [kw] = 1000 watts)***
c)	**State the various commercial losses in Transmission Distribution systems. Also state energy conservation techniques adopted for reducing the losses.**
Ans:	**Following are the commercial losses in Transmission Distribution systems:** **((Any four commercial losses expected: 1/2 Mark each)** 1) Make unauthorized extension of loads. (Direct Hooking) 2) Errors in meter reading & recording (faulty meter). 3) By passing the meter. (unmetered supply & unmetered bills) 4) Improper testing & calibration of meters. 5) Stopping the meters by remote control. 6) Changing the sequence of thermal wiring. 7) Changing the C.T. ratio. 8) Intentional burning of meters. **The methods of reducing commercial losses in distribution system: (2 Marks)** ➢ **These can be reduced by:** Installing summation meters for a group of customers to detect pilferage, fixing responsibility (on personnel) of the amount power drawn and amount of supplied by the agency personnel, installing accurate meters properly tested, resorting to regular testing/calibration of meters, conducting surprise raids/checks on consumers premises to detect theft or pilferage. ➢ These remedies lead to proper evaluation of the energy produced, distributed and utilized. They will lead to avoidance of improper /unwarranted use of available energy which in turn reduces the energy requirements by some scale in turn leading to saving in energy sources.

d)	**Explain the following energy conservation techniques: (i) By reducing I^2R losses in Trans. system (ii) By optimizing distribution voltage.**
Ans:	**i) By reducing I^2R losses in Trans:** **(2 Marks)** 1. Opting for low resistance All Aluminum Alloy conductors (AAAC) in place of conventional aluminum cored steel reinforced (ACSR) lines. 2. Increasing the system voltage leads to reduction in the line current transmitted that leads to lower I^2R losses. 3. Using relevantly suitable means to reduce the line currents to lowest possible values by maintaining the power factor near unity (reactive power control, power factor improvement) 4. Use of voltage controllers to maintain the voltage level at rated levels (not allowing the voltage to fall that leads to higher line currents) 5. Marinating proper distance (as low as economically possible) between consumer and distribution transformer. **(ii) By optimizing distribution voltage:** **(2 Marks)** Optimization of system voltage is maintaining the voltage of the system at the rated/specified level such that the related load requirements are most satisfactorily fulfilled and at the same time the losses/abnormal conditions related to over voltages/ under voltages are eliminated/reduced. There is fall in efficiency and quality of output with both these adverse/abnormal voltage conditions. **For example;** High voltages to resistance loads such as ovens etc. lead to excessive currents that create unnecessary heating leading to power losses in the supply lines and load. Also over voltages to motors leads to higher iron losses and higher torque that is not needed. Hence these are to be avoided. Under voltages to motors leads to excessive currents being drawn to take up the load resulting in higher supply line power losses. Thus maintaining the voltages at the specified levels leads to energy savings/conservation.

e)	**State the incentives and penalty related to following tariff structure: (i) Max. demand tariff (ii) Load factor tariff**
Ans:	**(i) Max. demand tariff :** **(Incentives : 1 Marks and Penalties : 1 Mark each)** **Incentives :-** 1) If consumer is used M.D. above 75 % to 85 % of saction contract demand than , consumer will gate 0.75 % rebeat on the energy bill. 2) If consumer is used M.D. above 85 % to 100 % of saction contract demand than , consumer will gate 1 % rebeat on the energy bill. **Penalties :-** 1) If consumer is used M.D. above 100 % of saction contract demand than , consumer has to pay more demand charges 150 % for use of extra M.D. 2) If consumer is used M.D. below 50 % of saction contract demand than , consumer has to pay minimum demand charges 50 % of saction contract demand. **ii) Load factor :** **(Incentives & Penalties : 2 Mark each)** 1. This incentive is applicable to the consumers where payment of arrears has been granted by the MSEDCL, & the same is being made as scheduled. 2. Consumers having load factor above 75% up to 85%: rebate of 0.5% on the energy charges for every 1% increase in load factor. 3. Consumers having load factor over 85% will be entitled to rebate of 1% on the energy charges for 1% increase in load factor from 85% The total rebate under this head will be subject to a ceiling of 15% of the energy charges for that consumer. 6. The load factor rebate is given only if the consumer has no arrears MSEDCL 7. The payment is made within 7 days from the date of bill or within 5 days of the receipt of the bill whichever is later. 8. In case the billing demand exceeds contract demand in any month, then the load incentive will not be payable in that month. 9. The billing demand definition excludes the demand recorded during the non peak hours ie. 22 hrs to 6 hrs & so even if maximum demand exceeds the contract demand in that duration, load factor incentives would be available 10. However, the consumer would be subjected to the penal charges for exceeding the contract demand & has to pay the applicable penal charges.

f)	**How the application of tariff system helps to reduce energy bill?**
Ans:	**Following application of Tariff system to reduce the energy bill:** **(Any four point expected: 1 Mark each)** Rate of payment/ schedule of rates on which charges to be recovered from electricity consumer or Rate at which electrical energy is supplied to consumer is defined as Tariff. Following are some points from which energy bills can be reduced by proper tariff:- 1. **EC by improving Reducing Fixed /Demand charges :** ➢ By reducing unnecessary load, optimization of power consumption by equipments, proper load distribution /scheduling. 2. **EC by improving Reducing Energy charges:** ➢ Switching off unwanted load, shifting load to off-peak period, Using energy efficient lamps and apparatus. 3. **EC by improving Prompt payment of bills and taking advantages of incentive / discount**. ➢ (Prompt payment discount of 1% on monthly energy bill excluding taxes & duties). ➢ creating awareness of Self discipline among consumers for less energy consumption 4. **EC by improving Power Factor Incentive:** ➢ By improving p.f. and maintaining at > 0.95, (incentive is 1% of amount of monthly bill including energy charges, ASC, FAC & fixed /demand charges but excluding taxes & duty for every 1% improvement in p.f. above 0.95) 5. **EC by improving Load Factor Incentive:** ➢ load factor above 75% up to 85% will be entitled to a rebate of 0.75% on energy charges for every percentage point increase in load factor from 75% to 85% ➢ Consumers having a load factor above 85% will be entitled to a rebate of 1% ➢ Consumers will be entitled to a total rebate of 15% . ➢ Generate load curve which helps to observe energy use trend (Monitor power consumption and max. demand) ➢ Rescheduling of loads, storage of products, shedding of non-essential loads.

6. **EC by Avoiding penalty for exceeding contract demand:**

- In case a high tension consumer exceeds his contract demand he will be billed at the appropriate demand charges for demand actually recorded and will be charged at the rate of 150% of the prevailing demand charges for the excess demand over the contract demand
- Re calculate and estimate existing connected load and assuming proper DF, decide max. demand.

7. **EC by improving Reactive power compensation:**

- Some utilities charge for reactive power consumption.
- By providing capacitor bank and maintaining optimum p.f.(also reduces max. demand)

OR

1. Energy Bill is decided by following points also :
   - Load factor of the consumer
   - Maximum demand of the consumer
   - Power factor of the consumer.
   - TOD tariff system

2. Time of use metering:-
   - In this method the day, month & year are divided into tariff slots.
   - Then apply higher tariff rates at peak load periods & low tariff rates at off peak load periods.
   - Therefore automatic control on use of energy is done by customer.
   - It is customer's responsibility to control his own use & pay accordingly.

3. Domestic use meter:-
   - Domestic variable rate meters normally gives peak & off peak tariffs.
   - In such installation a simple electromechanical time switch may be used.

4. Getting benefit by improving energy efficiency:-
   - Power factor incentives can be taken by installing power factor correcting devices at Consumer level.
   - Give discount on the monthly energy bill is available to all consumer categories if bill are
   - Paid within seven days from issue of the bill.

Q.4 (A)	**Attempt any THREE of the following :** **12 Marks**
a)	**State advantages of electronic ballast compare to electrical ballast.**
Ans:	**advantages of electronic ballast compare to electrical ballast:** **(Any four Advantages expected: 1 Marks each)** 1. Instant light 2. Lighter in weight 3. power saving is up to 35% 4. Heat output is negligible, that reduces load on air conditioning. 5. Improved power factor 6. Operates at low voltage **7.** Enhances life of lamp
b)	**State the scenario of power transmission losses at state level, national level, in developed countries and global level.**
Ans:	**scenario of power transmission losses at state level, national level, in developed countries and global level:** **(Any four point expected: 1 Mark each)** 1) In our nation electrical generation for over all country electrical generation is 253200 MW up to June 2012. 2) Out up this total electrical generation 68% is by thermal power station, 16 % is hydro power station, 8 % is gas power station, 4% is due to oil consumption, 2 % by nuclear power station and 2 % is non- conventional energy source (Solar, wind etc). 3) In our country per capta energy conservation is 733 KWH per year but in USA it is 13647 KWH per year. 4) In our country due to globalization and industrialization electrical power demand is continuously increases. 5) In our country total T & D losses are 23 % out of total energy generation. 6) In the Delhi and Jammu & Kashmir state there maximum T & D losses it is near about 40 % to 50 % . 7) These T & D Losses are due to improper design of power system network, all types of electrical machines, poor quality of T & D lines etc. By using the proper energy conservation techniques, these losses can be improved.

c) State the need of cogeneration in present scenario.

Ans:

Need for co-generation in present scenario: **(Any four point expected: 1 Mark each)**

1. In conventional power plant efficiency is only 35% & remaining 65% of energy is lost.
2. The conventional system uses energy of fuel to produce Electrical energy or Thermal energy. Where as co-generation system produces both electrical energy & thermal energy from same flues.
3. The overall efficiency of energy use in co-generation can be up to 85% and above.
4. Lower volumes of CO_2 emissions compared to the conventional system where separate production of electricity & heat.
5. In co-generation system, heat generated is by-product in electricity generating process. This heat can be used for other processes. Due to this energy cost are lowered.
6. Limited need of cooling water in co-generation system therefore reduces thermal pollution.

OR

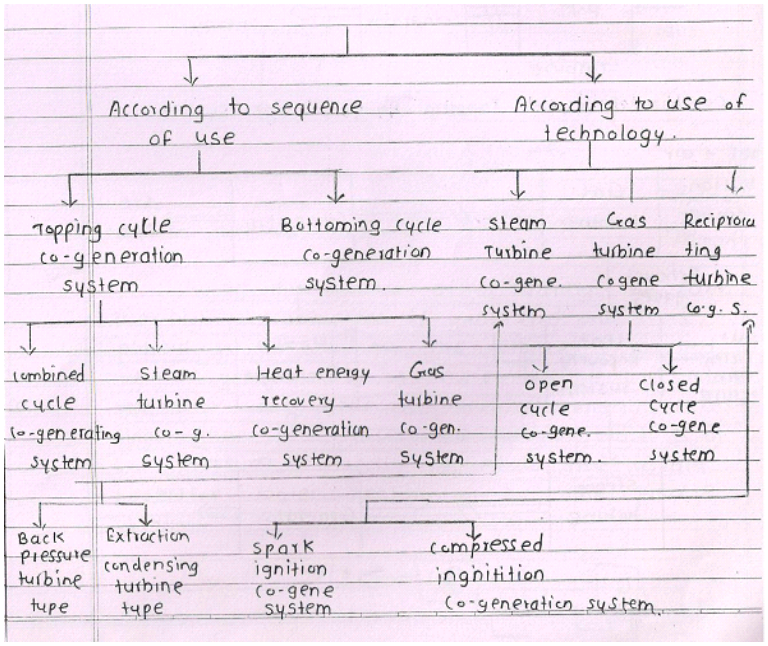
Need for co-generation in present scenario:

1. Reduces energy demand.
2. Reduces rise in energy cost.
3. Provides economical solution to energy shortages.
4. Increases financial capital.
5. Increases environmental value.

d) State the classification of cogeneration system based on sequence of energy use.

Ans:

Classification of cogeneration system based on sequence of energy use: **(4 Mark)**



Q.4 (B)	Attempt any ONE of the following : 06 Marks
a)	**A 50 kW motor with 86% efficiency is considered to replacement by 89% efficiency motor. What will be the energy saving, if operational hours per year is 6000 hr ?**
Ans:	**Given data:** Motor output : 50 KW, full load efficiency : 84%, No. of Hrs = 6000 Hrs **Case I : full load efficiency : 86%,** Power drown by motor = $\frac{KW}{efficiency}$ ---------- **(1/2 Mark)** Power drown by motor = $\frac{50}{0.86}$ Power drown by motor = 58.1395 *KW* ---------- **(1 Mark)** Cost of energy consumed = power drown by motor x working hours Cost of energy consumed = 58.1395 x 6000 Cost of energy consumed = Rs. 3,48,837/- ---------- **(1 Mark)** **Case II : full load efficiency : 89%,** **Power drown by motor** = $\frac{KW}{efficiency}$ ---------- **(1/2 Mark)** Power drown by motor = $\frac{50}{0.89}$ Power drown by motor = 56.1797 *KW* ---------- **(1 Mark)** **Cost of energy consumed** = power drown by motor x working hours Cost of energy consumed = 56.1797 x 6000 Cost of energy consumed = Rs. 3,37,078.20 /- ---------- **(1 Mark)** **Saving in energy per year** = Case I - Case II Saving in energy per year = Rs. 3,48,837– Rs. 3,37,078.20 Saving in energy per year = Rs. 11,758.80/- ---------- **(1 Mark)**
b)	**State and explain the desirable characteristics of a Tariff.**
Ans:	**The desirable characteristics of a Tariff:** **(Any Six point expected: 1 Mark each)** 1. It should be easy to understand to consumer. 2. Easy to calculate. 3. Tariff should be attractive i.e. It should not be too high or too low. It should be

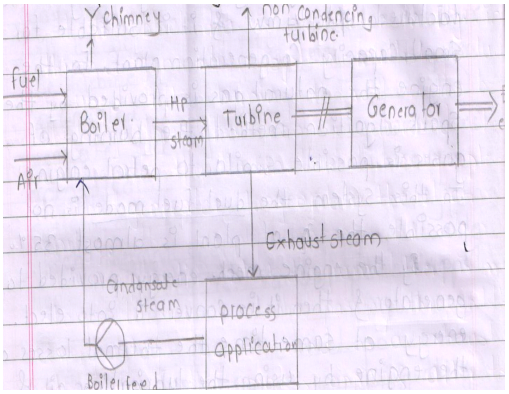
reasonable.

4. Tariff should be economical as compare to other types of energy sources.
5. Tariff should be different for different types of consumers.
6. Tariff must be fair, so that different types of consumers are satisfied with rate of electrical energy charges.
7. Tariff should be framed into two parts i.e. fixed charges + running charges.
8. Tariff should be high during peak load period .
9. Tariff should be low during off load period.
10. For industrial consumer, in addition to basic tariff incentives and penalty related to PF and LF should be considered.

Q.5 **Attempt any FOUR of the following :** **16 Marks**

a) **Draw and label steam turbine cogeneration system.**

Ans: **label diagram of steam turbine cogeneration system** : **(4 Marks)**



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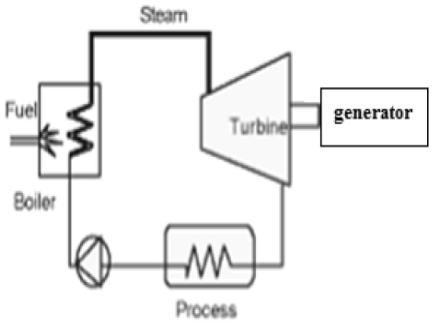
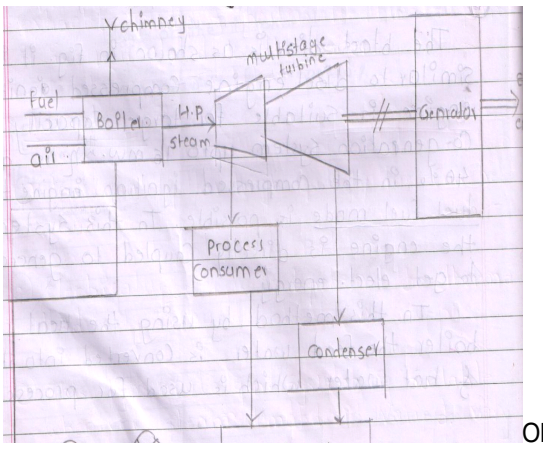


Back pressure steam turbine co-generation system.

OR

Extraction Condensation Turbine co-generation:



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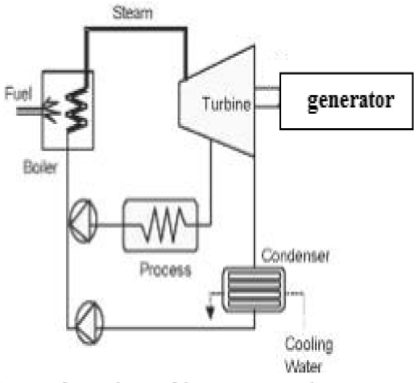


Extraction condensation turbine co-generation

b) State the advantages of adoption of cogeneration system in an industry.

Ans: **The advantages of adoption of cogeneration system in an industry:**

(Any four advantages expected: 1 Mark each)

1) Co-generation can meet both power & heat needs.
2) Less costly.
3) Very high efficiency.
4) Reduction in emission of pollutants due to reduced fuel consumption.
5) A much more efficient use of primary energy can be achieved than with a separate production of electricity & heat.
6) In this system heat generated is by-product in electricity generating process.
7) It can maintain grid stability.
8) Due to decentralization of electricity it avoids transmission losses & makes system more efficient.

c) List out the energy conservation equipments related to • Lighting system • Induction motor

Ans: Energy conservation equipments related to:

1. Lighting System: **(2 Mark)**

1. Luxmeter
2. Power Analyzer
3. Voltage Stabilizer
4. Electronic Ballast
5. LED Lamp
6. Control gear or Regulators
7. Lighting transformer

2. Induction Motor: **(2 Mark)**

1. Power factor Meter
2. Power Analyzer
3. Digital Voltmeter
4. Digital Ammeter
5. Wattmeter
6. Different types of starter

d) State the comparison between soft starter and conventional DOL starter.

Ans: **(Any four point expected : 1 Mark each)**

Sr. No.	Soft starter	Direct on-line starting (DOL)
1	Smooth starting	Starting with small jerk
2	Low current peak	Very high current peak **6.5 to 8.5 x Motor Current**
3	Variable starting torque	Huge mechanical stresses on equipment due to uncontrolled starting torque
4	Negligible voltage dip	Voltage dips causes flickering of lights
5	Energy Saving	Affects Maximum Demand
6	Zero Maintenance	More Maintenance

e) Name the energy audit instruments used for measuring following parameters :
- **All elect. parameters (V, I, P, Q, P.J)**
- **Lamp output**
- **Combustion of fuel**
- **Liquid flow**
- **Process temperature**
- **Presence of harmonics**
- **Fuel efficiency**
- **Gas leak**
- **Speed of rotating device**

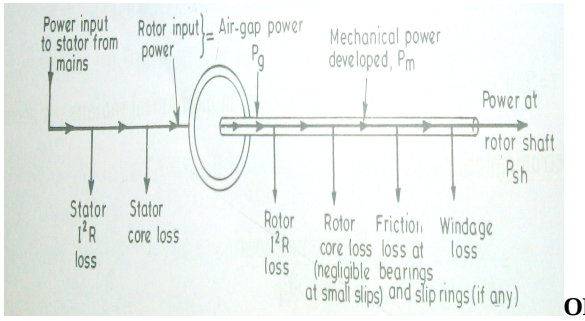
Ans: **Name the energy audit instruments used for measuring following parameters:** **(4 Mark)**

S.No	Parameters	Name of Instruments
1	All elect. parameters (V, I, P, Q, P.J)	Power Analyzer, Digital Multimeter
2	Lamp output	Lux Meter
3	Combustion of fuel	Electronic Combustion Analyzer,
4	Liquid flow	Flow meter
5	Process temperature	Thermometer and Temperature indicator
6	Presence of harmonics	Power Analyzer
7	Fuel efficiency	Fuel efficiency Monitor
8	Gas leak	Gas leak Detector
9	Speed of rotating device	Digital Tachometer and Stroboscope

f) What is `energy flow diagram' '? State its significance.

Ans: **Power flow diagram of induction motor:**

(Flow Diagram : 2 Marks & Signification: 2 Mark)



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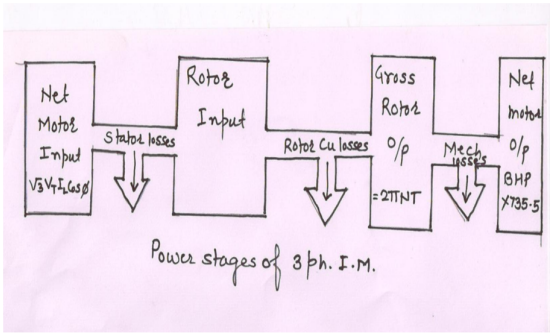

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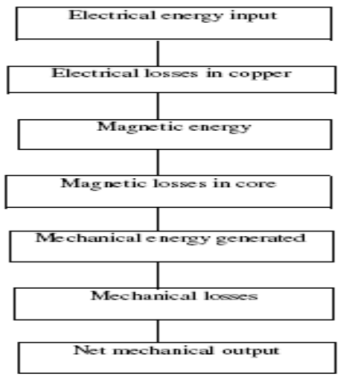


	Significance of energy flow diagram: 1. Energy flow diagram also known as Sankey diagram is a specific type of flow diagram in which the width of the arrow is proportional to quantity of energy. Length of the arrows has no bearings with the quantity of energy. 2. These diagrams indicate the flow of energy in a process and help identifying the quality and quantity of energy. 3. The input of energy begins from left of the diagram. The outputs (useful and leakages/losses of energy are shown in diagram.
Q.6	**Attempt any FOUR of the following : 16 Marks**
a)	**Explain how technical losses can be reduced by use of energy efficient transformer in Transmission and Distribution system.**
Ans:	**Technical losses can be reduced by use of energy efficient transformer in Transmission and Distribution system.** **(Any four point expected: 1 Mark each)** 1. The energy efficient transformers have low loss materials (core and winding), and are designed optimally to give the best performance. 2. Reduction in magnetizing current leads to lower losses again. 3. Due to the low loss core (amorphous core) materials the iron losses are reduced by around 70 % leading to increase in the all day efficiency. 4. Also the resin cast transformers have low losses due to which their efficiency rises to 98 % even at low loads especially for distribution transformers. 5. It may be higher for power transformer. Thus the overall transmission & distribution efficiency improves.
b)	**State and explain the factors that govern the selection of cogeneration system for an industry.**
Ans:	**The factors that govern the selection of cogeneration system for an industry: (4 Marks)** The factors that govern the selection of cogeneration systems are very much site/situation specific. The local factors such as the thermal energy requirements etc play an important role. Also the availability of the relevant opportunities and other related items decide the selection. They are broadly as follows:

1) Base electrical load matching:

The co-generation system is designed to meet the minimum electricity demand. The remaining power required is purchased from the utility grid.

2) Base thermal load matching:

The co-generation system is designed to supply the minimum thermal energy requirement. Stand by boilers/ burners are used if the demand for heat is higher.

3) Electrical load matching:

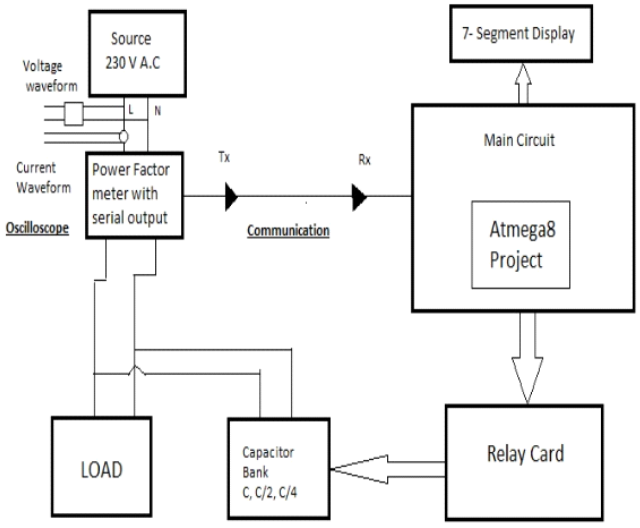
This is stand alone system. The co-generation system is designed such that total electricity required is generated. Therefore this co-generation system is totally independent of the electricity utility grid. Sometimes if energy demand is higher, auxiliary boilers are used.

4) Thermal load matching:-

The co-generation system is designed such that the total heat energy require is generated. If required energy demand is higher electricity purchased from grid.

c) State the working principle and operation of Automatic power factor controller used in Transmission and Distribution system.

Ans: **Diagram of Automatic over factor controller:** **(Figure: 2 Mark & Working : 2 Mark)**



Automatic Power factor control:

- The pf controller is used to maintain the pf at unity across the lines it is connected.
- Maintaining the pf at unity leads to reduction in the current through the lines as real power = apparent power x pf. The apparent power decides the MD for which the

	consumer is billed. ➢ For a certain motor the current in the lines will depend on its pf which is lagging. For higher pf near unity maintained at the motor terminals the line currents are minimized leading to lower MD and hence saving in MD charges. ➢ Also as the current is minimized line voltage drops and power losses are reduced leading to improvement in the motor power supply system efficiency. The pf controller does not efficiency. **OR** 1. Please check if required kVAr of capacitors are installed. 2. Check the type of capacitor installed is suitable for application or the capacitors are de rated. 3. Check if the capacitors are permanently 'ON'. The Capacitor are not switched off 4. when the load is not working, under such condition the average power factor is found to be lower side. 5. Check whether all the capacitors are operated in APFC depending upon the load operation. 6. Check whether the APFC installed in the installation is working or not. Check the CT connection is taken from the main incomer side of transformer, after the fix compensation of transformer. 7. Check if the load demand in the system is increased. 8. Check if power transformer compensation is provided.
d)	**Define : (i) Energy Audit (ii) Simple payback period (iii) Return on Investment (iv) Energy Audit Instruments**
Ans:	**(i) Energy Audit:-** **(1 Mark)** An energy audit is an inspection, survey and analysis of energy flows, for energy conservation in a building, process or system to reduce the amount of energy input into the system without negatively affecting the output(s). **(ii) Simple payback period:-** **(1 Mark)** **Payback period** in capital budgeting refers to the period of time required to recoup the funds expended in an investment, or to reach the break-even point. **OR**

$$= \frac{\text{Capital cost of the project/equipment (Rs)}}{\text{Net annual savings (Rs)}}.$$

(iii) Return on Investment (ROI):- **(1 Mark)**

ROI measures the amount of return on an investment relative to the investment's cost.

The return on investment formula:

$$ROI = \frac{(\text{Gain from Investment} - \text{Cost of Investment})}{\text{Cost of Investment}}$$

OR

$$= \frac{\text{Net Profit due to the project (Rs)}}{\text{Cost of Investment in that project (Rs)}} \times 100$$

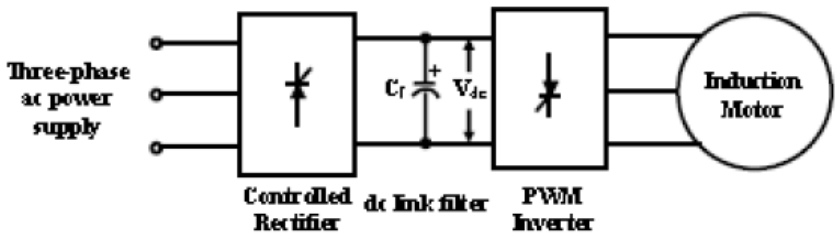
(iv) Energy Audit Instruments:- **(1 Mark)**

For the energy audit purpose we use different instrument for measurement of different parameters is called as energy audit instrument.

e) State the difference between "Walk Through Audit" & "Detailed Audit".

Ans: **(Any Four point expected: 1 Mark each)**

S.No	Walk Through Audit	Detailed Audit
1	It is also called as the preliminary audit or screening audit or simple audit	It is also called as general audit or site energy audit.
2	It is simplest, quickest and least expensive way.	It is nothing but expansion of the simple audit
3	There are two resources: i) Operation and maintenance staff collects the data. ii) Serving utility provides this information.	In this method collect the information of system operation, but in more detailed form as compared to simple audit.
4	Basic information of the energy system in the premises is collect as well.	Auditor collects utility bills of an year to find out tariff structure, usage profile etc
5	Only main issues are covered in walk through procedure.	This type of audit focus all the most suitable energy conservation measures for the system.

f)	State the use of "Variable Frequency Drive". State its advantages.
Ans:	**Following are the benefits of variable frequency drive:** **(Any Four benefits expected: 1/2 Mark each)** 1) Energy saving. 2) Better process control. 3) Cost saving. 4) Less maintenance cost. 5) Large life for bearing & motors. 6) Improved power quality. 7) Smooth starting. 8) Improved power factor 9) Reduced M.D. Charges **Reason for energy conservation is achieved by using VFDs: (2 Mark)** 1) Energy saving due to optimum use for applications. 2) Smooth starting. Can star avoided. 3) Smooth speed control changing operations are avoided as smooth increasing (to 300%) or decrease (to 11%) of the rated speed is possible. 4) Better process control, (with Micro controller and IGBT (Insulated Gate Bi-polar transistor) optimization of input variables to get required outputs 5) Less maintenance cost due to optimum working. 6) Higher life span with very low losses for bearing & motors due to which we have improved optimal output power quality. 

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