Important Instructions 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 should assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given importance (Not applicable for subject English and Communication Skills).

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner should give credit for any equivalent figure/figures drawn.

5) Credits to 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 (as long as the assumptions are not incorrect).

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.

7) For programming language papers, credit may be given to any other program based on equivalent concept

1 a) Attempt any Three of the following 12

1 a) i) State the importance and need of energy conservation (any four points)

Ans:

85% of Primary Energy Sources comes from fossil fuel and non-renewable energy sources. In last 200 years we have consumed 60% of all resources. Fossil fuels like coal, oil takes number of years to form through natural cycle. Because of rise in population, industrialization, change in life style, there is steep rise in energy demand. To meet these demands we have consumed maximum fossil fuel. Hence these fuels are on the verge of depleting soon. Up-till now more than 60% of all sources have been consumed. 2 marks

Rate of consumption of energy sources is more than that of formation. If rate consumption of energy increase similarly then no sources will be left over for next generation.

Hence energy conservation is needed as it,

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

1 a) ii) State any four methods for energy conservation in lighting systems.

Ans:

Following are techniques used in lighting system to conserve the energy in domestic, commercial and industrial installations.

1) Optimum use of natural light.
2) Use recommended Luminance levels.
3) Use energy efficient luminaries and support devices.
4) Replace conventional lamp source by energy efficient lamps.
   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.

   Each point 1 Mark any four points = 4 marks
5) Use light control equipment or control gears.
6) Use servo stabilizer for lighting.
7) Installation of exclusive transformer for lighting purpose circuits to control and maintain the voltage to the lighting fixtures.
8) Periodic survey of lighting system for aging effects, faulty operation.
9) Regular cleaning and maintenance of the sources to maintain light levels.

1 a) iii) List out any four factors considered while selecting motor for home appliances.

Ans:

As home appliances are low power devices the motors are basically fractional hp

motors. 1 mark each point any four points.

1) Depending on application the starting torque is decided (normally the motors start and run on full load) and motor with suitable characteristics is selected. (eg shaded pole motor).
2) The break down torque (maximum torque).
3) Depending on application the full load speed needed is decided and motor with suitable characteristics is selected. (eg shaded pole motor).
4) The domestic supply voltage must be known to select the motor.
5) The domestic supply frequency must be known to select the motor.
6) Speed variation required must be known to decide the motor.
7) Only motors with variable voltage speed control are normally suitable.
8) The frequency of starting and stopping must be known along with duty cycle of operation.
9) The time for which the device will be operated continuously (to decide the rating).

1 a) iv) List advantages of amorphous core (any four)

Ans:

Major energy losses in distribution transformers are the iron losses (hystserisis + eddy current) that occur continuously in the core while maintaining the operating flux throughout the day. These core losses in the conventional transformer whose core is made of silicon alloyed grain oriented iron laminations occur constantly during the time when the transformer is working for all loads: no load included.Amorphous cores are made of metallic glass (iron alloy) alloy that have these losses lower by about 70 %.

- Due to lower iron losses the loss at all loads is reduced resulting in significant improvement in the efficiency which may increase upto 98.5 % even at low loads.
- This material has high electrical resistivity. This is 2-3 times higher than that of silicon steel. This is partially responsible for low core (eddy current) losses.
- Amorphous steel has lower hysteresis losses. So, this means that less energy wasted in magnetizing & demagnetizing during each cycle of supply current.
- The all day efficiency of the transformers is increased that results in huge energy savings.
- As losses get reduced cooling problems are reduced and heat related problems are reduced.

Each point 1 Mark any four points = 4 marks

1 b) Attempt any one: 6 marks

1 b) i) List the methods of energy conservation in an induction motor (any four).

Ans:

1. Rewinding of motor with better quality conductors.
2. Minimizing idle & redundant running of motor.
3. Energy conservation by motor operating in star mode for loads less than 40% of motor rating (to reduce voltage dependent losses)

1 pt 2 Mks, 2 pts 3 Mks,

4. Energy conservation by improving power quality (specified voltage, form factor & frequency)
5. Periodic adequate maintenance of motor.
6. Using variable voltage variable frequency drives to suit load needs.
7. Using soft starter to reduce starting losses and protect under abnormal situations
8. Matching motor ratings with required load.

3 pts 4 Mks, 4 pts 6 Mks

1 b) ii) Write stepwise procedure for assessing energy efficiency of existing lighting system.

Ans:

1 mark each step (variations allowed with the gist being parallel to given)

Step I: 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.

Also note fuse ratings as placed.

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 analyser, 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 analyse failure rates of lamps, ballasts, and actual life expectancies from past data.

Step VI:

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.

2 Attempt any four 16 marks

2 a) State advantages of non conventional energy sources (any four). 1 mark each point any four = 4 marks

Ans:

(points to be covered)

1) Most of these are abundantly available: in-exhaustible.
2) Most of these are freely available in nature.
3) Most of these are very less polluting.
4) Eco friendly technologies.
5) Conversion devices technology can be globally standardized as same nature of energy is available everywhere.
6) Using non conventional energy sources as biomass etc. reduces the resulting pollution due to accumulation of wastes.

2 b) Describe following energy conservation techniques in lighting systems:

i) Replacing lamp sources.
ii) Using light control gears.

Ans:

i) Replacing lamp sources: (table not compulsory) 2 marks

Area	Lamp Type		Power Saving	
	Existing	Proposed	Watts	Efficiency
Commercial complex	TL 40 W	TLD 36 W	4 W	10 %
Street lighting	HPMV 250W	MHL 100w	150 W	60 %
Domestic	TL 40 W	T-8 28 W	12 W	30 %
	GLS 60 W	CFL 25 W	35 W	58 %

The saving in power/energy is reflected in percentage.

ii) Using light control gears:

Flexibility can be obtained in lighting system by using following light control systems. It also saves power by switching off and by reducing luminance.

- **Grouping of light points**: Grouping of lighting system, which can be controlled manually or by timer control. In this two or more no, of light points can be controlled by one switch. Such types of controllers are used in corridor lighting, go-downs, street lighting.

- **Microprocessor based / infrared based / sensor controlled controllers.** As a single control unit microprocessor based controllers are used which switch on /off as per the working schedule. System can also be programmed month wise, year wise and even season wise. E.g., corporate house, Big Offices, Industrial Complexes, industries, exhibition halls and malls In addition to this infrared controller can be used for dimming or switching circuits. The lighting control can be obtained by using logic units located in the ceiling, which can take pre-programmed commands and activate specified lighting circuits. 2 marks
- **Separate transformer** for lighting circuits is installed to provide constant rated voltage and isolation from the other circuits.
- Installing servo controlled stabilizer for lighting systems.

2 c) State benefits of VFDs (any four points)

Ans:

Following are the **benefits** of variable frequency drive: 1 mark each point any four = 4 marks

1) Energy saving due to optimum use for applications.
2) Smooth starting. Can start the motor under load smoothly.
3) Smooth speed control, Can increase (to 300%) or decrease (to 11%) of the rated speed. Hence higher speed range.
4) Better process control, (with Micro controller and IGBT (Insulated Gate Bi-polar Transistor).
5) Cost saving.
6) Less maintenance cost due to optimum working.
7) Large life for bearing & motors.
8) Improved output power quality.

2 d) State the opportunities for energy conservation in transformer (any four points)

Ans:

Opportunities for energy conservation in transformer

1. Using energy efficient transformer
2. Use amorphous core containing ferromagnetic elements like iron, cobalt alloy. This material has high resistivity than silicon steel. Due to this low core losses so less energy wasted. Each point 1 Mark any four points = 4 marks
3. Use encapsulated dry type transformer.
4. Use tapped transformer, usually auto wound for saving in copper.
5. Use thinner lamination in transformer core to reduce iron losses.
6. Adequate Periodic maintenance of transformer
7. Use better quality low resistance copper conductors to reduce copper losses.
8. Maintain operating voltage, form factor and frequency at the rated values (power quality) so that losses are minimized.
9. Use better quality insulation materials to improve overload capacity.

2 e) Describe energy conservation of induction motor by minimizing idle and redundant running.

Ans:

Points to be covered:

Minimizing idle and redundant running of motors: idle /redundant running leads mainly to following:

1) Loss of energy as the no load power drawn is approximately about 12 % to 16 % of rated power output in most of motors.
2) Un-necessary heat production at friction points as bearings leading to wearing of bearing.
3) Motor being inductive load the pf of such running is low leading to unnecessary losses line losses.
4) Reduction in overall energy efficiency over period of time.

2 marks

Hence avoiding long periods of such operation of motors is needed to maintain a higher energy efficiency of operation and conserve energy.

- This can be achieved by switching off the motors during such extended periods of operation.
- Operating the motors at low voltages just to keep them running near their normal speeds.
- Redundant running implies the equipment is working without any effect on the production of quantity or quality. Unless these are operating for safety consideration stoppage of these motors can lead to large saving.

2 marks

3 Attempt any four: 16

3 a) State economic and environmental aspect of of energy conservation(4 points).

Ans:

Economic aspect: Energy conservation means minimizing the use of energy by new techniques. If we conserve energy ultimately generation of energy is minimizes that means we save the fuel required for generation. It will be beneficial for economy i.e. the import of fuel is minimized **Environmental Aspect:** If we conserve energy, generation minimizes ultimately the flue gases from combustion of coal minimizes hence the effect of flue gases on environment reduces. It is helpful for minimizing the global warming conservation of non-renewable energy aspect: If we conserve energy, we reduce generation. It is helpful for conserving the fuel such as coal, oil, natural gas etc.

2 marks

The answers broad coverage:

Economic aspects of energy conservation:

- Expenses incurred to implement the energy conservation techniques must be properly recoverable to affect savings as early as possible (well before the life span of the equipment is over).
- The ROI must be sufficiently attractive.
- Payback period must be such that the cost of the technology used for conservation must be recovered properly and benefits start early.
- Running costs of the energy conservation techniques must as low as possible.
- Must be as cheap as possible.

2 marks

Environmental aspects of energy conservation:

- Technological installation/modification aspects for energy conservation must be non-polluting.
- Using non-conventional energy resources for power generation leads to saving/protecting our environment.

- Reducing the wasteful use of precious natural resources in energy conservation scenario leads to lesser pollution.
- Reduction in pollution leads to lesser green house effect gases and thus protects our environment.
- The freely available natural resources of air and water will be less impure thus requiring very little processing for use by humans. (Note that mineral water is produced by polluting the environment).
- Lesser pollution means healthy environment for living.

3 b) Compare energy efficient motor and standard motor on the basis of construction, efficiency, speed and starting torque.
Ans:

Sr	Points to compare on	Energy Efficient Motor	Standard Motor
1	Construction	Thin & low loss laminations of core. Longer core. Large dia. Copper conductor , Low loss fan , aerodynamic designed rotor optimized design , quality control procedure in manufacturing	Laminations with higher flux densities. Cu/Al conductor with smaller dia. Al fan, standard quality controlled manufacturing process.
2	Efficiency	Higher upto 92 %	Lower upto 86%
3	Speed	(Slightly higher) nearer to synchronous, slip about 2.5 to 3% at full load.	Slip around 4 % at full load.
4	Starting torque	Good as required.	Sufficient

1 mark each point

3 c) State any four advantages of dry type transformer over conventional oil filled transformer.
Ans:
Advantages of dry type transformer over conventional oil filled transformer. Any four 1 mark each.
The dry type transformer are superior due to the following;

1) An encapsulated dry type transformer is a type of energy efficient transformer.
2) The coils are encapsulated in epoxy resin and are air cooled hence elaborate cooling arrangements are not needed.
3) Saving in oil requirement & its cost and replacement during maintenance.
4) Losses are lower compared to oil filled ones due to which efficiency increases to 98 %.
5) Maintenance is highly reduced due to absence of oil.
6) Work of coil level maintenance is limited to replacement of phase column winding and hence very quick.
7) Ratio of power rating to weight of transformer is increased in dry type.
8) Very safe on short circuit conditions.
9) Fire retardant and very much useful for sensitive & important locations such as

Railways, Hospitals etc.

10) Core vibration does not result in cracking because of unique encapsulation & sealing process.

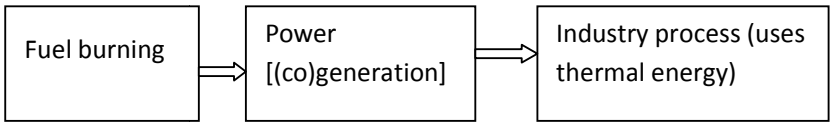
11) Flexible cladding material is also highly chemical & moisture resistant.

3 d) With block diagram state classification of cogeneration system based on sequence of energy generation.

Ans:

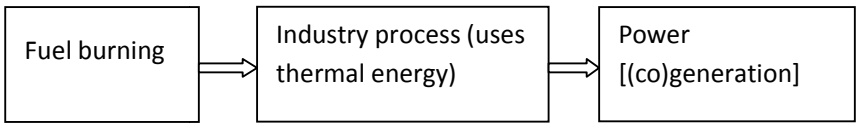
Points expected to be covered:

1) Topping cycle: the fuel is used to first produce power and then thermal energy which is a by-product of the cycle and is used to supply process heat or other thermal requirements. Suitable where the processes of the industry need low heat (temperatures). 1 mark



1 mark

2) Bottoming cycle: the fuel is used to generate high temperature thermal energy required for the process of the industry and then the heat rejected is recovered and used to generate power. 1 mark



1 mark

3 e) The tariff of Rs.150/kVA of maximum demand and 8 paise per unit consumed, having load factor 30 % and MD = 100 kW. Find overall cost per unit at

i) UPF and

ii) 0.7 PF.

Ans:

Assume given MD tariff is monthly.

MD in kVA = MD (kW)/PF, average load = MD x Load factor = 30 kW.

Monthly units consumed = average load x hours in month 1 mark

= 30 kW x (30 x 24)hrs = 21600 kWh.

Energy charges per month = 21600 x 8/100 = Rs 1728/-

i) At UPF:

MD (kVA) = 100 kW/1 = 100 kVA. 1 mark

MD charges = 100 x 150 = Rs 15000/-.

Monthly bill = MD charges + energy charges

=15000 + 1728 = Rs 16728/-.

Overall cost per unit per month = 16728/(monthly units consumed),

1 mark

= 16728/21600 = Rs 0.7444 = 74.44 paise.

ii) At 0.7 PF:
MD (kVA) = 100 kW/0.7 = 142.86 kVA.
MD charges = 142.86 x 150 = Rs 21429/-.
Monthly bill = MD charges + energy charges
= 21429 + 1728 = Rs 23157/-.
Overall cost per unit per month = 23157/(monthly units consumed),

= 23157/21600 = Rs 1.072 1 mark

4 a) Attempt any three: 12

4 a) i) List advantages of cogeneration (any four).
Ans:
Advantages of co-generation: 1 mark each point maximum 4 marks
1) Co-generation can meet both power & heat needs.
2) Less costly.
3) Higher system efficiency as energy wastage is highly reduced.
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) Due to decentralization of electricity it avoids transmission losses & makes system more flexible.

4 a) ii) State important objectives of tariff (any four)
Ans:
Following are the objectives of tariff- 1 mark each point maximum 4 marks
1) Cost of investment in generation, transmission & distribution equipment must be recovered.
2) Cost of operation, supplies, maintenance & losses must be recovered.
3) Cost of metering, billing, collection & miscellaneous services must be recovered.
4) It should be simple and understandable to the public.
5) It should be uniform over large population.
6) It should provide incentive for using power during the off peak hours.
7) It should have a provision for higher demand charges for high load demanded at system peak.
8) Should have a provision of penalty for low power factor.
9) There is a suitable profit on the capital investment.

4 a) iii) What is demand side management? How is it used for energy conservation?
Ans:
(DSM)- Demand side management side management is also known as energy demand management. Energy demand management usually take actions that

improve the quality of energy consumed by users. It also includes actions for reduction of peak demand. 1 mark

Benefits of demand side management-

1) Reduction in high prices of electricity.
2) Reduction in customer energy bills.
3) Reduction in heavy investment in new power plant.
4) Reduction in heavy investment in transmission network.
5) Reduction in heavy investment in distribution network.
6) Increase in stability of electricity.
7) Reduction in air pollution.
8) Reduction in dependency on foreign energy sources.

Any two points 1 mark.

Role of Demand side management (DSM) in present energy Scenario-

Demand side management includes any activity that would directly or indirectly lead to increase energy efficiency. Management/scheduling of loads with respect to time is significant in view of the applicable tariff structure and incentives therein. It improves quality of the power system. Demand side management reduces high prices of electricity. It also reduces customer bill, heavy investment in new power plant. 2 marks

4 a) iv) List factors affecting performance of transmission and distribution systems.

Ans:

Factors affecting Performance of Transmission system:

1. Line resistance, inductance and capacitance: Opting for low resistance All Aluminum Alloy conductors (AAAC) in place of conventional Aluminum cored steel Reinforced (ACSR) lines increases efficiency. 2 marks

2. Voltage and its type (AC/DC): HVDC is used to transmit large amount of power over long distance or for interconnection between asynchronous grids. UHVAC/EHVAC used for long and medium distances.

3. Use of voltage controllers to maintain the voltage level.

4. Reactive power transmitted; reactive power controllers or reactive power compensating equipments such as static VAR controllers.

Factors affecting Performance of Distribution system.

1. Balanced/unbalanced loading; Balancing of phase load: As a result of unequal loads on individual phase sequence, components cause overheating of transformers, cables, conductors, motors. Thus increasing losses and resulting in motor malfunctioning under unbalanced voltage conditions. 2 marks

2. **Power factor:** Low power factor will lead to increased current and hence increase losses and will affect the voltage.

3. **Optimization level of distribution system:** The optimum distribution system is the economical combination of primary line (HT) distribution transformer and secondary line. To improve voltage HT/LT line length ratio should be improved.

4 b) Attempt any one 6 marks

4 b) i) List technical and commercial losses in transmission and distribution systems. How they can be reduced?
Ans:

Different **technical losses** in transmission & distribution system-

1) A loss due to insufficient investment on transmission & distribution system & result is overvoltage. 2 marks
2) Losses due to random growth of sub transmission &distribution system.
3) Losses due to large scale rural electrification through long 11KV & LT lines.
4) Losses due to many stages of transformation. (Large no. of transformers).
5) Losses due to improper load management.
6) Losses due to unsatisfactory reactive power compensation.
7) Losses due to poor quality of equipment used.

These can be reduced by proper investment in relevant equipment, properly planned growth/expansion, judicious load management by optimization in all respects without compromise in quality of power, installing proper reactive power control devices, and using standard quality equipment. 1 mark

Different **commercial losses** in transmission & distribution system-

1) Losses due to unauthorized extension of loads. 2 marks
2) Losses due to errors in meter reading & recording.
3) Losses due to bypassing the meter.
4) Losses due to improper testing & calibration of meters.
5) Losses due to stopping the meters by remote control.
6) Losses due to changing the sequence of thermal wiring.
7) Losses due to changing the C.T. ratio.
8) Losses due to intentional burning of meters.

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. 1 mark

4 b) ii) What is ABC analysis? State its use.
Ans: (points to be covered)
-ABC Analysis,
Normally 20% of a given population (items) represents 80% of a specific characteristic. 1 mark
ABC analysis provides a mechanism for identifying different categories of activities/stocks that will require different management and controls. 1 mark

1) A class inventory: It contains 10 to 20 % of the items that account for 70% of 1 mark

total value.

2) B class inventory: This type of inventory contains 25 to 35 % items that account for 20% of total value. 1 mark

3) C class inventory: This inventory contains 40 to 50 % items that account for 10% of total value. 1 mark

The above principles of ABC analysis can be applied to energy conservation / audit to optimize the expenses and energy required for the various processes. The audit helps to identify such items and the costs / energies involved there in. Thus it is possible to minimise the expenses and energy losses by proper application of the ABC analysis wherein we optimise the expenses without loss of quality. 1 mark

5 Attempt any four: 16 marks

5 a) With block diagram describe operation of steam turbine cogeneration system.
Ans:

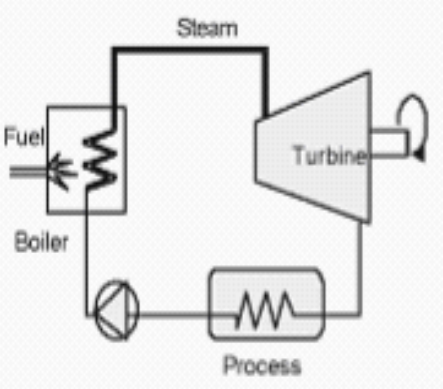


Diagram 3 marks

Back Pressure turbine cogeneration system

As seen above the power is generated before the steam thermal energy is fed to the process of the industry and utilized therein. 1 mark
Fuel burnt heats up the water to steam in the boiler. The steam is at high temperature and pressure and is fed to turbine to generate electric power. The exhaust from the turbine is utilized for the process in the industry.

OR

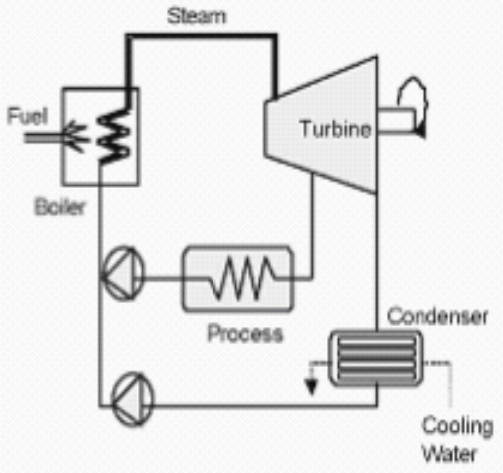


Diagram 3 marks

1 mark

Extraction Condensation turbine cogeneration system

Here the steam produced is fed to the turbine and the steam is extracted at an intermediate pressure and utilized for the process as seen in the diagram. The exhaust steam is fed to the condenser and the condensate is further utilized and fed to boiler along with the output from the process.

5 b) State the power factor incentives and load factor incentives for HT-1 consumers.

Ans:

Power factor incentive:

1. It is given to consumers who have maximum demand based tariff and provided with meters to measure their power factor.

2. Whenever the average power factor is more than 0.95, an incentive at the rate of 1% of the amount of the monthly bill is given. It includes energy charges, Additional supply charges(ASC) , Fuel Adjustment cost (FAC) & fixed / demand charges .But excludes taxes and duties for energy 1% improvement in the power factor.

2 marks

3. For power factor of 0.99 – effective incentive 5%
4. For unity power factor - effective incentive 7%

Load factor incentive:

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%

2 marks

5. 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.

5 c) List methods of energy conservation in transmission and distribution systems (any four).

Ans:

Methods of Energy conservation in Transmission system:

1. Opting for low resistance All Aluminum Alloy conductors (AAAC) in place of conventional Aluminum cored steel Reinforced (ACSR) lines.
2. HVDC is used to transmit large amount of power over long distance or for interconnection between asynchronous grids.
3. Use of voltage controllers to maintain the voltage level.
4. Use of reactive power controllers or reactive power compensating equipments such as static VAR controllers.

2 marks

Methods of Energy conservation in Distribution system.

1. Balancing of phase load: As a result of unequal loads on individual phase sequence, components cause overheating of transformers, cables, conductors, motors. Thus increasing losses and resulting in motor malfunctioning under unbalanced voltage conditions.

2 marks

2. **Energy conservation by using power Factor controller**: Low power factor will lead to increased current and hence increase losses and will affect the voltage.

3. **Optimization of distribution system:** The optimum distribution system is the economical combination of primary line (HT) distribution transformer and secondary line. To improve voltage HT/LT line length ratio should be improved.

5 d) List causes of global warming (any four).

Ans:

Global warming is the increase in the average temperature of the Earths near surface air and oceans. Over the last 100 years it was found that the earth is getting warmer and warmer unlike previous 8000 years when temperature have been relatively constant.

Any four points 1 mark each

Causes:

1) Excessive (unnatural) fossil fuel combustion leading to emission of GHG (green house gases) as CO_2, CFCs etc.
2) Production of gases such as HFCs, PFCs, SF_6 etc. in industrial processes.
3) Emissions from solid waste combustion.
4) Methane production in and nitrous oxide emissions.
5) Changes in land use pattern.
6) Increased Agricultural activities with more artificial/synthetic/processed inputs.

5 e) State the effects of air pollution (any four).

Ans:

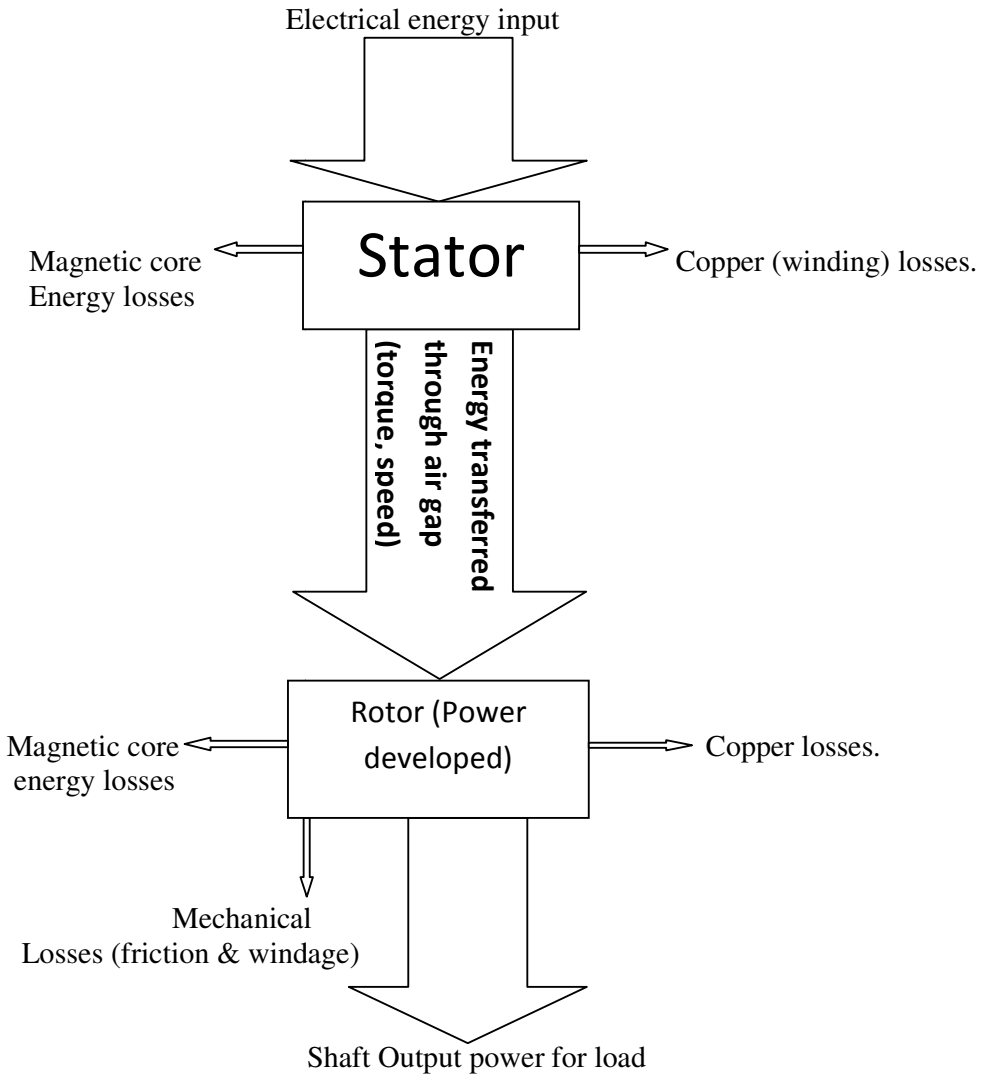
1) Global effects-Climate change, Ozone depletion, Green house effect, Global warming.
2) Effect on human being-Due to nitrogen oxide, sulphur dioxide, oxides of carbon causes irritation of eyes, lung cancer.
3) High concentration air pollutants damage leaves of plants.
4) Metal parts corrosion.
5) Damage to paint surfaces, stone monuments.
6) Damage forests, plantations & agricultural plants leading to food shortages.
7) Sulphur dioxide and oxides of nitrogen can cause acid rain which reduces PH value of soil. Soil can become infertile and unsuitable for plants.
8) Mixture of smoke and fog can reduce the amount of sunlight received by plants. Therefore photosynthesis process gets disturbed.

Any four points 1 mark each (or other relevant ones)

5 f) Draw energy flow diagram of induction motor. Completely Labeled correct diagram 4 marks, Else 2 marks for partially labeled.

Ans:

The diagram must be drawn with thickness of block arrows approximately to represent the proportion of energies/powers at different stages.



6 Attempt any four. 16 marks

6 a) List factors for selection of cogeneration system (any four)

Ans:

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. — 1 mark each point = 4 marks

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.

6 c) List causes and effects of acid rains (any four)

Ans:

Causes of acid rain:-

1. Volcanoes and forest fire may emit sulphur dioxide gas which mixes with water vapour in the air and sunlight to create small amount of sulphuric acid.
2. Burning coal oil and natural gas in power station gives off sulphur dioxide gas again.
3. Burning coal, oil in vehicle engines gives off nitrogen oxide gas creating acids when in contact with water vapour.
4. When fossil fuel are burnt, carbon, sulphur, nitrogen elements are released into the atmosphere again responsible for acidic atmosphere/rains.
5. Large scale air pollution causing acid rain.

½ mark each cause any four = 2 marks

Effect of acid rain:-

1. The needles and leaves of trees turn brown and fall off.
2. Acid rain damages metal and limestone.
3. Acid rain contributes to deterioration of paint stone of buildings, bridges.
4. Acid rains contribute to the corrosion of metals.
5. Acid rain flows into streams, lakes after falling on forests, building and roads. Resulting in death of aquatic animals.
6. Humans can become seriously ill and can even die from effect of acid rain.
7. Acid rain kills microorganisms.
8. The railway industry and the aeroplane have to spend a lot of money to repair the corrosive damage done by acid rain.
9. Acid rain reduces minerals from the soil and then it affects the growth of plants.

½ mark each effect any four = 2 marks

6 d) List instructions to carry out energy audit in chemical industry (any four) — 1 mark each any four = 4 marks

Ans:

1) Flowmeter.
2) Thermometers.
3) Gas analyser.
4) PH meter.
5) Hydrometers.
6) Voltmeters.
7) Ammeters.
8) Wattmeters.
9) Energymeters.
10) Lux meters.
11) Meggers etc. and other relevant meters

6 e) State two Electricity Act 2003.

Ans:

Salient features of Electricity Act 2003.

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 marks each point any two = 4 marks.

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 distribute power in rural area.

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 / Appellate Tribunal:** State Electricity Regulatory 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.

6 f) State any four opportunities in present scenario to reduce global warming.

Ans:

1) Implementing policies that reduce the formation of Green House Gases at the national and international levels.
2) Afforestation;
3) Stringent pollution limiting norms for fuel burning machines such as vehicles / facilities (industries).
4) Encouraging use of energy efficient machines with incentives.
5) Creation of awareness among people about its hazards.
6) Ban on aerosols and burning of garbage.
7) Implementing steps to avoid / limit forest fires.

Any four points 1 mark each = 4 marks.