



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 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 principal components indicated in the 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 of some questions credit may be given by judgement 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



Q.1 A) Attempt any three: -----12 Marks

a) Classify energy sources. (Each point 1 Marks any four points expected)

ANS: There are two types of energy sources.

1. Conventional energy sources 2) Non-Conventional energy sources

SR. NO.	Conventional energy sources	Non-Conventional energy sources
1	Not easily available in nature.	Easily available in nature.
2	Availability is limited.	Availability is unlimited.
3	Some special processes are required to drive these sources.	Most of sources are freely available in nature.
4	More air pollution.	Less air pollution.
5	Some sources are harmful & dangerous for human, animals & plants. Due to pollution.	Not harmful & dangerous.
6	Sufficient contribution to global warming.	Less contribution to global warming.
7	Production & running cost is high.	Production & running cost is Less.
8	Losses are more.	Less Losses.
9	Less efficiency.	High efficiency.
10	Power generation is high.	Power generation is less.
11	Large space required.	Less space required.
12	High reliability.	Less reliability.
13	Ex. Coal, natural gas.	Ex. Solar, wind.

b) Quick recommended level of illumination for two places in houses, colleges, shops & assembly shops. (Each point 1 Marks)

ANS: Recommended level of illumination

- 1) Houses: Study room-50-100 lux, Hall-75-100 lux.
- 2) Colleges: Class room-150-250 lux, Laboratories-500-750 lux.
- 3) Shops: PC work-500-750 lux, Shop landscape-500-750 lux.
- 4) Assembly shops-Workshop-750 lux, Office landscape-750 lux.

c) State the benefits of using energy efficient motor. (Each point 1 Marks any four points expected,)

ANS: Following are the benefits of using energy efficient motor-

- 1) Longer insulation life.
- 2) Longer bearing life.



- 3) Lower heat output.
- 4) Less vibrations.
- 5) Low losses.
- 6) Longer warranties.
- 7) Decreases energy costs.
- 8) Pollution free.
- 9) High efficiency.
- 10) Good performance.

d) State the methods of energy conservation in transformer. (Each point 1 Marks any four points expected.)

ANS: Following are the methods of energy conservation in transformer-

- 1) Use Energy efficient transformer.
- 2) Use amorphous metal transformer.
- 3) Use Encapsulated dry type transformer.
- 4) Use tapped transformer, usually auto wound.
- 5) Use thin laminations in transformer core.
- 6) Periodic maintenance of transformer.

B) Attempt any one: -----6 Marks

a) List six energy conservation techniques adopted in indoor lighting system. (Each point 1 Marks any six points expected.)

ANS: Following are the energy conservation techniques adopted in indoor lighting system-

- 1) Use recommended Luminance levels.
- 2) Use energy efficient luminaries.
- 3) Replace lamp source by energy efficient light control equipment.
- 4) Use light control gears.
- 5) Use servo stabilizer for lighting.
- 6) Installation of exclusive transformer.
- 7) Periodic survey of lighting system.

b) State different technical losses in transmission system. How these losses can be reduced. (Each point 1 Marks, Three Technical losses ,Three reduction points expected)

ANS: Different **technical losses** in transmission system-

- 1) Insufficient investment on transmission & distribution system, & result is overvoltage.
- 2) Random growth of sub transmission & distribution system.
- 3) Large scale rural electrification through long 11KV & LT lines.



- 4) Many stages of transformation.
- 5) Improper load management.
- 6) Unsatisfactory reactive power compensation.
- 7) Poor quality of equipment used.

These losses can be **reduced by-**

Short term measures:-

- 1) Identification of the weakest area in distribution system.
- 2) Improving of weakest area for maximum benefits of the limited sources.
- 3) Installation of additional distribution transformer.
- 4) Installation of shunt capacitors for improvement of power factor.
- 5) Use energy efficient transformer.

Long term measures:-

- 1) Detailed mapping of total primary & secondary distribution system.
- 2) Describing the various parameters such as conductor size, line length etc.
- 3) Compiling of data regarding existing loads, operating conditions, Expected future loads.
- 4) Preparation of long term plans for phase strengthening.
- 5) Estimation of financial requirements for improvement..

Q.2 A) Attempt any four: -----16 Marks

a) State & list four methods for improving energy scenario in the present situation in our Country. (Each point 1 Marks any four points expected.)

ANS: Following are the methods for improving energy scenario in the present situation in our Country.

- 1) Use energy efficient luminaries.
- 2) Use energy efficient Motors, soft starters, rewinding of motors.
- 3) Use energy efficient transformers.
- 4) Reactive power compensation.
- 5) Balance phase current, reduce technical & commercial losses.
- 6) Reduce ozone layer depletion, global warming, air pollution & acid rain etc.
- 7) Use energy flow diagram to detect losses.
- 8) Follow IE rules& regulations.



b) Define luminous intensity, luminous efficiency, coefficient of utilisation & depreciation factor. (Each definition 1 Marks)

ANS: 1) Luminous intensity:- The luminous flux emitted by light source per unit solid angle is called as the luminous intensity.

2) Luminous efficiency:- This is the ratio of luminous flux emitted by a lamp to the power consumed by the lamp.

3) Coefficient of utilisation:- A coefficient of utilization is a measure of the efficiency of a luminary in transferring luminous energy to the working plane in a particular area.

4) Depreciation factor:- The ratio of initial illumination on an area to the present illumination of the same area, used in lighting calculations to account for depreciation of lamp intensity and reflective surfaces.

c) State two benefits & applications of variable frequency drive. (Each point 1 Marks, Two benefits, Two applications points expected)

ANS: Following are the **benefits** of variable frequency drive:

- 1) Energy saving.
- 2) Better process control.
- 3) Cost saving.
- 4) Less maintenance cost.
- 5) Large life for bearing & motors.
- 6) Improved power quality

Following are the **applications** of variable frequency drive:

- 1) Centrifugal pumps
- 2) Pumps
- 3) Conveyers
- 4) Machine tools

d) Explain the use of amorphous metal & its advantages. (Each point 1 Marks, Two Uses, Two advantages points expected)

ANS: Use of amorphous metal-

- 1) Amorphous metal is an energy efficient metal. This metal containing ferromagnetic elements such as iron or cobalt alloy.
This material has high electrical resistivity. Result is low core losses.
- 2) Amorphous metal has lower hysteresis losses. Result is less energy wasted in magnetising & demagnetising during each cycle of supply current.
- 3) Amorphous metal have very thin laminations. Result is lower the eddy current losses.



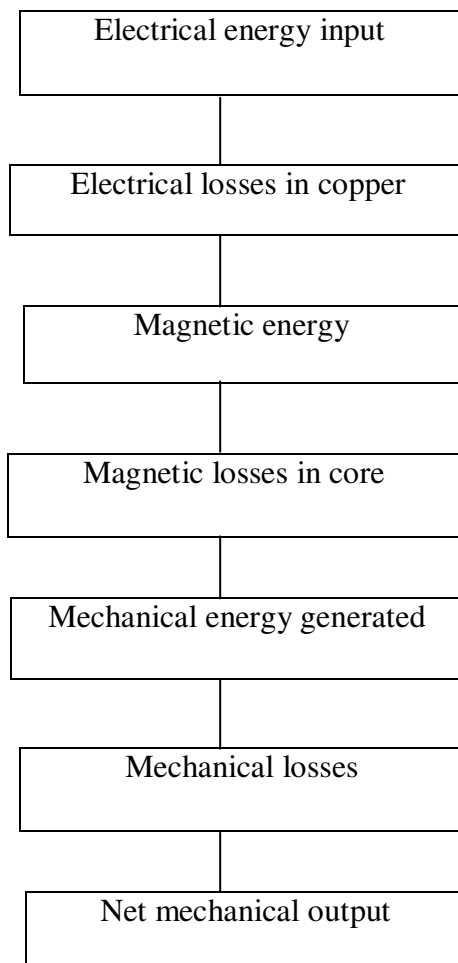
- 4) This metal reduces impact on global environment. This metal improves electrical characteristics.

Advantages of amorphous metal:-

- 1) Up to 75% energy saving using amorphous metal than conventional metal.
- 2) Reduced carbon dioxide emission.
- 3) Reduction in fossil fuel consumption.
- 4) Reduced magnetising current.
- 5) Better overload capacity.
- 6) High Reliability.
- 7) Excellent short circuit capacity.
- 8) Less maintenance cost.

- e) Draw power flow diagram of electrical motor & suggest methods of improving power quality in it.
(Methods-2 Marks & Figure-2 Marks)

ANS:





Methods of improving power quality in it:-

- 1) Voltage improvement and maintaining frequency at appropriate levels.
- 2) Increase power flow capacity.
- 3) Reduce losses.
- 4) Pollution free supply system.
- 5) Use quality anti friction bearings lubricants,
- 6) Use effective methods of cooling.

Q.3 Attempt any four: ----- 16 Marks

a) State four Necessities of energy conservation. (Each point 1 Marks any four points

Expected)

ANS: Following are the necessities of energy conservation-

- 1) Energy conservation reduces energy demand.
- 2) Reduces rise in energy cost.
- 3) Energy conservation is most economical solution to energy shortages.
- 4) Increases financial capital.
- 5) Increases environmental value.

b) Compare soft starters with conventional starters. (Each point 1 Marks any four points expected)

ANS:

Sr. No.	soft starters	conventional starters
1	Less losses	More losses
2	Negligible maintenance	High maintenance
3	Less vibrations	More vibrations.
4	Low failure rates	High failure rates
5	Manufactured with higher quality materials & techniques.	Manufactured with lower quality materials & techniques.
6	Smooth application	Rougher behaviour as compared

c) State the periodical maintenance necessary in power transformers, how does it result in energy conservation. (Each point 1 Marks any four points expected.)

ANS: A) Hourly maintenance:-

- 1) Check Winding temperature, ambient temperature & oil temperature.



B) Daily maintenance:-

- 1) Check oil level, if low, fill dry oil.
- 2) Check silica gel in the breather. Colour should be blue.

C) Quarterly maintenance:-

- 1) Check for proper working of cooling fans, circulating pumps etc.
- 2) Clean bushing. Tighten the connections.

D) Half yearly:-

- 1) Check dielectric strength of oil.
- 2) Check bushes & insulators.
- 3) Check cable boxes/ filter/replace oil.
- 4) Check earth resistance.
- 5) Check lightning arrestors.

E) Yearly maintenance:-

- 1) Check oil for acidity.
- 2) Check alarms, relays, contacts.
- 3) Check lightning arrestors.

F) Five yearly maintenance:-

- 1) Carryout overall inspection of the transformer including lifting of core & coils.
- 2) Clean the transformer with dry transformer oil.
- 3) Open the transformer for cleaning & re-assembling.

From considering all above points, it is easy to improve performance, Quality & efficiency of transformer. This reduces losses , energy wastage & saving the energy.

d) State factors governing selection of co-generation. (Each point 1 Marks any four points expected.)

ANS: Following are the factors governing selection of co-generation-

- 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 required is generated. If required energy demand is higher electricity purchased from grid.

e) Two monthly tariffs are offered

i) Rs. 3000+ Rs. 0.90 per kWh ii) Rs.3.0 per kWh

At which consumption per month is tariff is more suitable for a consumer.

ANS: Let x be the number of units at which charges due to both tariff become equal, then

$$3000 + 0.9x = 3.0x \text{ -----1 Mark}$$

$$3000 = (3.0-0.90) x$$

$$3000 = 2.10x$$

$$x = 1428.57 \text{ kWh. -----1 Mark}$$

At consumption less than 1428.57 kWh the 2nd tariff is suitable. -----1 mark

At consumption more than 1428.57 kWh the 1st tariff is suitable.-----1 mark.

Q.4 A) Attempt any three: -----12 Marks

a) State the need for co-generation & list its advantages. . (Each point 1 Marks, Two Need, Two advantages points expected)

ANS: **Need** for co-generation-

- In conventional power plant efficiency is only 35% & remaining 65% of energy is lost.
- The conventional system uses energy of fuel to produce Electrical energy or Thermal energy. Whereas co-generation system produces both electrical energy & thermal energy from same fuel.
- The overall efficiency of energy use in co-generation can be up to 85% and above.
- Lower volumes of CO₂ emissions compared to the conventional system where separate production of electricity & heat.
- 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 is lowered.
- Limited need of cooling water in co-generation system therefore reduces thermal pollution.



Advantages of co-generation system-

- 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 flexible.

b) List six objectives of tariff. . (Each point 1 Marks any six points expected)

ANS: Following are the objectives of tariff-

- 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 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.

c) State current balancing procedure and benefits of phase balancing. (Each point 1 Marks, Two Balancing, Two benefit points expected)

ANS: Current balancing procedure:

-Four-wire distribution feeders are made up of three phases & single phase sections. Customers are supplied through three phase or single phase.

-The currents in the three phase section are not at all completely balanced. So imbalance varies along the length of each feeder.

-If a single phase load is supplied from a three phase node, there are three possibilities for connecting the load. If there are two single phase loads supplied from a three phase node, there are six possibilities for connecting the load.



- In case of three phase loads, changing the phase sequence, unbalance the current. If lengths of feeders from phases are not same, unbalance the load & a current balance along the complete length of feeder is not possible.
- When three phase supply & connecting loads are imbalanced, then for balancing existing feeders it is need to get required balance with minimum number of changes to load.
- Therefore to produce satisfactory solution an appropriate optimization technique is required.
- the best balance is that, balance is achieved at the feeder supply point & also along the total feeder length.

Benefits of phase balancing:-

- 1) Balancing reduces feeder losses.
- 2) Balancing between phases tries to make uniform phase loading.
- 3) Balancing reduces reactive power losses.
- 4) Balancing improves voltage on feeder.
- 5) Balancing improves power transfer quality.

d) List technical & commercial losses in transmission & distribution. (Each point ½ Marks, 4 Technical, 4 commercial losses points expected max 4 marks)

ANS: Different technical losses in transmission & distribution system-

- 1) Insufficient investment on transmission & distribution system, & result is overvoltage.
- 2) Random growth of sub transmission & distribution system.
- 3) Large scale rural electrification through long 11KV & LT lines.
- 4) Many stages of transformation.
- 5) Improper load management.
- 6) Unsatisfactory reactive power compensation.
- 7) Poor quality of equipment used.

Different commercial losses in transmission & distribution system-

- 1) Make unauthorized extension of loads.
- 2) Errors in meter reading & recording.
- 3) Bypassing the meter.
- 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.



a) What is demand side management (DSM). List its benefits and role in present energy Scenario. (Definitions 2 Marks, 1 mark for each benefit any 4)

ANS: Demand side management (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.

Energy demand management system used to describe the actions of a supply utility.

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.

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.

b) In a multipurpose hall 250 fluorescent lamps of 40 W with chokes of 15 W. 150 are on for 10 hrs, and remaining for 12 hrs. 100 fans each 60 W with regulator of 10 W. 60 fans work for 10 hrs and remaining for 12 hrs. iron choke replaced by electronic choke of 1 W costing Rs 300 each. Fan regulators replaced by electronic regulators of 0.5 W each costing Rs 125. Calculate

- i) daily energy consumption before replacement
- ii) daily energy consumption after replacement
- iii) pay back period in days at Rs 5 per unit energy charge.

ANS:

- i) Before replacement:

Each tube circuit consumes $40\text{W (tube)} + 15\text{W (choke)} = 55\text{ W}$.

Each fan circuit consumes $60\text{W (fan)} + 10\text{W (regulator)} = 70\text{ W}$.

150 tubes for 10 hrs consume $150 \times 55 \times 10 = 82500\text{ Wh} = 82.5\text{ kWh}$



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Remaining 100 tubes for 12 hrs consume $100 \times 55 \times 12 = 66000 \text{ Wh} = 66 \text{ kWh}$

60 fans for 10 hrs consume $60 \times 70 \times 10 = 42000 \text{ Wh} = 42 \text{ kWh}$

Remaining 40 fans for 12 hrs consume $40 \times 70 \times 12 = 33600 \text{ Wh} = 33.6 \text{ kWh}$

Summing up all the above consumptions

Total daily energy consumption before replacement = 224.1 kWh

(1 mark for above calculations)

ii) After replacement:

Each tube circuit consumes $40\text{W (tube)} + 1 \text{ W (choke)} = 41 \text{ W}$.

Each fan circuit consumes $60\text{W (fan)} + 0.5 \text{ W (regulator)} = 60.5 \text{ W}$.

150 tubes for 10 hrs consume $150 \times 41 \times 10 = 61500 \text{ Wh} = 61.5 \text{ kWh}$

Remaining 100 tubes for 12 hrs consume $100 \times 41 \times 12 = 49200 \text{ Wh} = 49.2 \text{ kWh}$

60 fans for 10 hrs consume $60 \times 60.5 \times 10 = 36300 \text{ Wh} = 36.3 \text{ kWh}$

Remaining 40 fans for 12 hrs consume $40 \times 60.5 \times 12 = 29040 \text{ Wh} = 29.04 \text{ kWh}$

Summing up all the above consumptions

Total daily energy consumption after replacement = 176.04 kWh

(1 mark for above calculations)

Daily energy expenses = daily consumption x rate of energy (per unit)

iii) Daily energy expenses before replacement:

$$= 224.1 \times 5 = \text{Rs } 1120.5/-$$

Daily energy expenses after replacement:

$$= 176.04 \times 5 = \text{Rs } 880.2/-$$

$$\text{Daily saving in Rs on energy consumed} = 1120.5 - 880.2 = \text{Rs } 240.3/-$$

(1 mark for above calculations)

$$\text{Expenditure on replacing 250 chokes} = 250 \times 300 = \text{Rs } 75000/-$$

$$\text{Expenditure on replacing 100 fan regulators} = 100 \times 125 = \text{Rs } 12500/-$$

$$\text{Total expenses on replacement} = \text{Rs } 87500/-$$

(1 mark for above calculations)

$$\text{Payback period in days} = (\text{total expenses on replacement}) / (\text{daily savings})$$

$$= 87500 / 240.3 = 364.13 \text{ days} = 365 \text{ days (1 year)}$$

(2 marks for above calculations)



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Q.5 Attempt any four: -----16 Marks

- a) Compare steam & gas turbine type of co-generation. (Each point 1 Marks any four points expected)**

ANS:

Sr. No.	Steam turbine	Gas turbine
1	The steam turbine co-generation system uses boiler, steam turbine and generator.	The gas turbine co-generation system uses compressor, combustion chamber, gas turbine and generator.
2	Less maintenance.	More maintenance.
3	Steam turbines have a more start-up time.	Gas turbines have a short start-up time.
4	The low pressure exhaust from steam turbine is used for industrial processes.	The exhaust from the combustion chamber is used as a process heat.
5	Low Installation Cost	More Installation Cost

- b) State how tariff is useful in reducing energy bill & energy conservation. (Each point 2 Marks any two points expected)**

ANS: Following are the methods in reducing energy bill & energy conservation-

- 1) 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.

- 2) Domestic use meter:-

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

- 3) 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.

State the sources of reactive power & methods for compensating. . (Each point 1 Marks, Only Two sources and Two methods of compensating)

ANS: Sources of reactive power

- 1) Low pf Induction motors.
- 2) Synchronous Compensators.
- 3) Capacitive and Inductive Compensators.
- 4) Overhead Lines and Underground Cables.



- 5) Transformers
- 6) Consumer Loads
- 7) Industrial (induction type) heating furnace.
- 8) Arc lamps.

Methods for compensating reactive power:

- 1) Use of capacitors
- 2) Use of a synchronous condenser.
- 3) Use of phase Advancers.

c) What is global warming, list its effects. . (Definition 1 Marks, Three effect points expected)

ANS: Global warming-Global warming is the increases in the average temperature of the earth near surface air & oceans.

Effect of global warming-

- 1) The melting of glaciers (Ice).
- 2) The raising of sea level.
- 3) The drying & heating of forests causing wildfires (uncontrolled fire).
- 4) Warming of ocean surface.
- 5) The reduction in rainfall.
- 6) High temperature, can increases pollution of water & air, which harm the human body.
- 7) Water level in earth decreases.
- 8) There is harmful effect on corals (boat).

d) State the causes & remedies for air pollution. (Each point 1 Marks, Two causes, Two remedies points expected)

ANS: **Causes** for air pollution-

- 1) Global & particles released from burning from fossil fuel like coal, petrol & diesel.
- 2) Vehicle exhaust, agricultural activity, mining & energy generation responsible for air pollution.
- 3) Industrial process such as chemical factories, sugar factories, paper industries, fertiliser plants responsible for air pollution.
- 4) Transportation is an increasing source of air pollution.
- 5) Domestic causes of air pollution include fossil fuel, LPG, wood, kerosene.
- 6) An agricultural cause of air pollution includes spreading of chemicals, fertilisers & pesticides.
- 7) Other causes of air pollution include dust & broken rock particles in mining operation.

Remedies for air pollution-

- 1) Global effects-Climate change, Ozone depletion, Green house effect, Global warming.
- 2) Effect on human being-Due to nitrogen, sulphur dioxide, oxides of carbon causes irritation of eyes, lung cancer.



- 3) High concentration air pollutants damage leaves of plants.
- 4) Due to air pollution metal corrosion.
- 5) Due to air pollution degradation of paints, stones, monuments.
- 6) Due to air pollution decreases UV radiation.
- 7) Due to air pollution damage forests, plantations & agricultural.

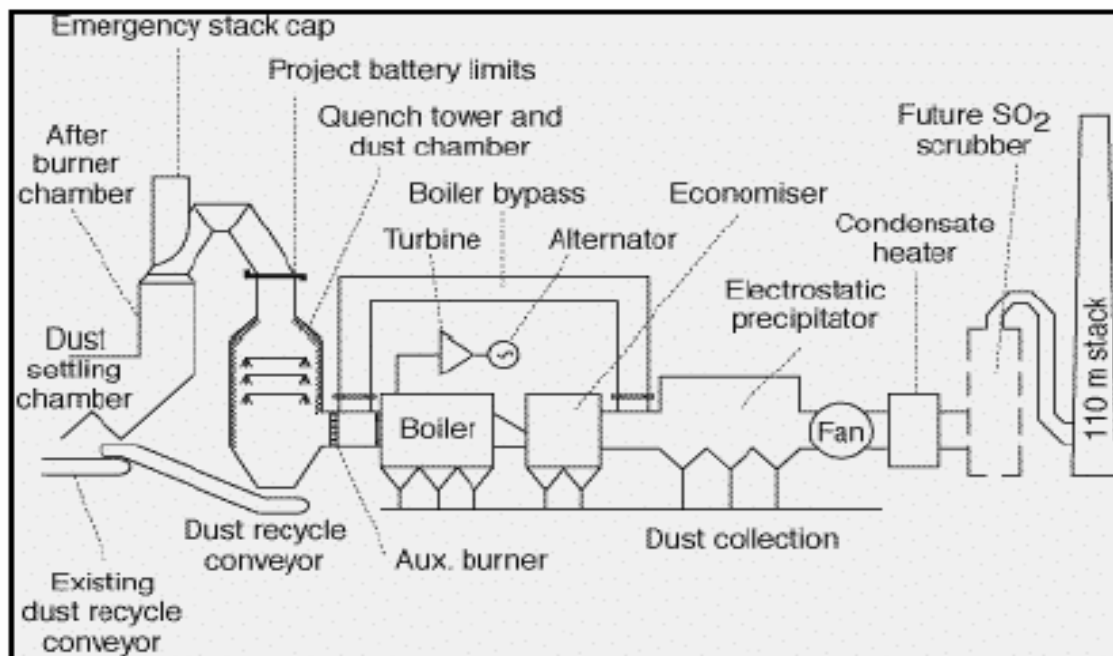
Q.6 Attempt any four: -----16 Marks

a) With diagram explain bottoming cycle type of co-generation. (Explanation-2 Marks & Figure-2 Marks)

ANS: Bottoming cycle type of co-generation-

- In bottoming cycle, high temperature heat energy is produced using the primary fuel. To Generate electricity the heat rejected from the process is used.
- The rejected heat is taken from the recovery boiler & then it is applied to the turbine. This operates the generator.
- For manufacturing processes heat at high temperature is required in furnaces & ovens.
- Therefore bottoming cycle are suitable for cement, steel, ceramic, gas, petrochemical industries.

Diagram of bottoming cycle type of co-generation





ANS:

It is to be noted that the savings are affected only in demand charges and not in energy units as energy units do not change.

Given demand charges are for month i.e. Rs 100/ kVA/month.

Maximum demand in kVA at a p.f = 0.8 lag = $240/0.8=300$ kVA

Annual bill = 12 x monthly demand charges + Energy charges

$$= 12 \times 100 \times 300 + 1.5 \times 50000$$

$$= \text{Rs } 435000/- \quad \text{-----1 Mark}$$

When p.f is raised to 0.95, the maximum demand in KVA

$$= 240/0.95 = 252.63 \quad \text{-----1 Mark}$$

Annual bill = $12 \times 100 \times 252.63 + \text{Rs } 1.5 \times 50000$

$$= \text{Rs } 378156/- \quad \text{-----1 Mark}$$

$$\text{Annual saving} = 435000 - 378156 = \text{Rs } 56844/- \quad \text{-----1 Mark}$$

c) State the effects of harnessing energy on environment. (Write Any Four points – 1 Mark to each point)

ANS: Following are the effects of harnessing energy on environment-

Energy has been harnessed by humans for millennia. The energy is used for fire for light, heat, cooking and for safety.

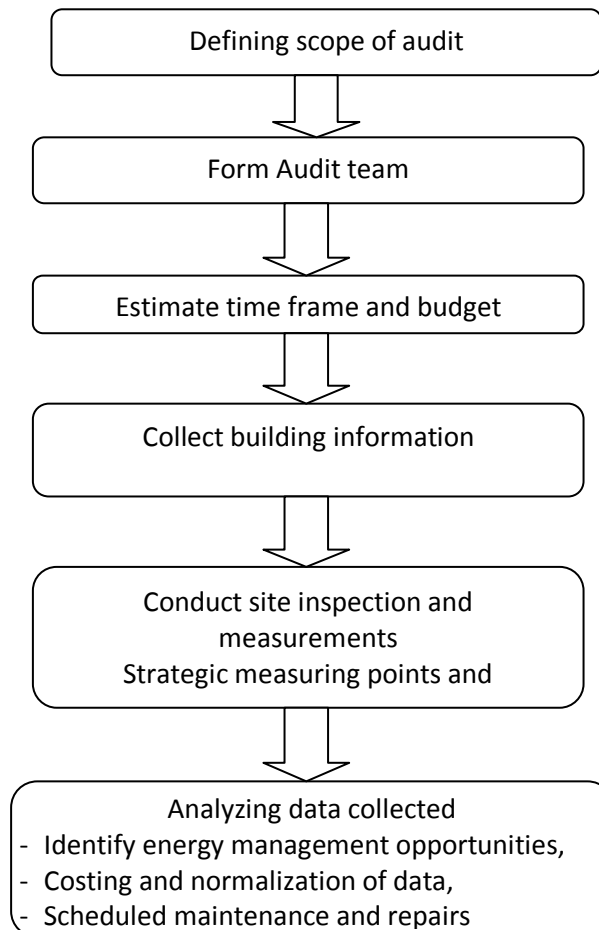
- 1) Consumption of fossil fuel resources lead to global warming and climate change.
- 2) Nuclear power plants use large quantities of water for steam production and for cooling, affecting fish and other aquatic life.
- 3) Manufacturing of photovoltaic cells (PV) produces some toxic materials and chemicals.
- 4) When burned, petroleum products emit carbon dioxide, carbon monoxide and other air toxins, all of which have a negative effect on the environment.
- 5) Reservoirs(Hydro power plant) lead to the creation of methane, a harmful greenhouse gas.
- 6) Coal mining has the potential to harm air, water and land quality if it is not done with proper care.
- 7) Biomass creates harmful emissions like carbon dioxide and sulphur when it is burned.



d) Draw flowchart for energy audit procedure.

ANS: Flowchart for energy audit procedure

(not all points are expected as they are, this chart is an ideal one.
Mention of all three levels is needed for award of 2 marks,
1 mark for very brief steps.
1 mark for expected outcome of audit)





e) State IE rules & regulations for energy audit. (Each point 1 Marks, Four points expected)

ANS: Rules & regulations for energy audit-

- 1) Check substation equipments i. e. Isolators, breaker panels, transformers, lighting distribution boards if required.
 - 2) Check flame proof equipment, termination at substation.
 - 3) Check flame proof & non flame proof motors.
 - 4) Check earthing system & hardware used, continuity test.
 - 5) Check lighting protection.
 - 6) Check high towers & lighting poles.
 - 7) Check environmental protection provided to the equipments.
 - 8) Check capacitor & panels for improvement of power factor.
 - 9) Check load balancing on all three phases of supply.
 - 10) Check scope for energy saving.
 - 11) Evaluate electrical safety for equipments at hazardous zones.
 - 12) Check healthiness of the cable.
 - 13) Check DG set & accessories.
 - 14) Check line diagram for electrical layout & earthing layout.
-