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 THREEof the following :** **12 Marks**
a)	**List conventional and non-conventional energy sources. (any four)**
Ans:	**1. Conventional Energy sources:** **(Any Two types expected: 1 Mark each)** 1.Thermal Power Plant (coal), 2. Hydro Power Plant 3. Nuclear Energy Power Plant 4. Diesel Power Plant 5. Natural gas 6. oil **2. Non-Conventional Energy sources:** **(Any Two types expected: 1 Mark each)** 1. Solar Power Plant (Solar Energy) 2. Wind Power Plant (Wind Energy) 3. Ocean waves and tides Power Plant (Tidal energy) 4. Magneto hydro dynamic (MHD) Power Plant, 5. fuel cell, 6. Biomass Power Plant, 7. Geothermal energy Power Plant
b)	**Define the following terms : (i) Illuminance (ii) Luminous flux (iii) Illumination (iv) Luminous efficacy**
Ans:	**i) Illuminance:** **(Each Definition : 1 Mark)** It is similar to illumination but it is for particular plane. Its unit is lux

	ii) Luminous flux :- The luminous flux is the total energy radiated by the light source in all direction. **iii) Illumination :-** The illumination is defined as the luminous flux falling on per unit area of the given surface on the working plane. The unit of illumination is lumens/m^2 OR 1 Lumens/m^2 = 1 Lux **iv) Luminous efficiency**:- This is the ratio of luminous flux emitted by a lamp to the power consumed by the lamp.
c)	**List energy conservation techniques in electrical motors.**
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 finishes 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 idel & redundant running. 9) By matching motor required load. 10) By Phase balancing. 11) By improving power quality. 12) Operating motor in star mode at light load.
d)	**State advantages of Energy Efficient motors as compared to conventional motors.**
Ans:	**Advantages of Energy Efficient motors as compared to conventional motors:** **(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 stator and rotor is less & optimum. 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.
Q.1 B)	**Attempt any ONE of the following: 06 Marks**
a)	**Describe the effect of following on Induction Motor : (i) Voltage Unbalance (ii) Harmonic Distortion**
Ans:	**i) Effect of harmonic distortion: (3 Mark)** Due to distortion of the main frequency waveform by harmonics produced due to solid state devices, electromagnetic devices, arcing devices the high frequency harmonics lead to increased copper losses and iron losses that results in over heating of motors (due to the harmonic voltages and resulting currents thereon). This leads to motor failures, lower life and improper torque speed characteristics. **ii) Effect of voltage unbalance: (3 Mark)** For three phase motors this leads to unequal currents in the three phase windings that result in unbalance in the fields produced due to which negative phase sequence currents are produced that cause oppositely rotating magnetic field to the normal one, leading to overheating in rotor
b)	**A 10 HP motor is used for 20 hrs per week to pump water. A new motor has to be replaced to save 5 kWh of energy during each hour. If the cost of new motor is 45,000. Calculate payback period with electricity cost of Z 4.20 per kWh.**
Ans:	**Given Data:** 10 HP, 20 Hrs/ week, energy saving: 5 KWh/hour, cost of new motor: R. 45000/- Energy cost : Rs. 4.20 / KWh $Pay\ back\ period = \frac{First\ \cos t}{annual\ \ savings}$ $\text{Output of motor in KW} = \frac{10\ H.P \times 735.5}{1000} = 7.355\ KW$ ---------- **(1/2 Mark)** $Annual\ \ KWh\ consumed\ by\ old\ motor\ = 7.355 \times 20\ hrs \times 4\ weeks \times 12\ months$ $Annual\ \ KWh\ consumed\ by\ old\ motor\ = 7060.8\ KWh$ ---------- **(1/2 Mark)** $Total\ annual\ \cos t\ of\ \ old\ \ motor\ = 7060.8 \times 4.20$

	$Total\ annual\ cost\ of\ old\ motor = Rs.\ 29655.36$ ---------- **(1 Mark)** $Annual\ KWh\ saved\ by\ new\ motor = 5 \times 20\ hrs \times 4\ weeks \times 12\ months$ $Annual\ KWh\ saved\ by\ new\ motor = 4800\ KWh$ ---------- **(1 Mark)** $Annual\ saveing\ by\ new\ motor = 4800 \times 4.20$ $Annual\ saveing\ by\ new\ motor = Rs.\ 20160$ ---------- **(1 Mark)** $First\ cost = Rs.\ 45000\ (assumed)\ because\ total\ cost\ of\ motor\ is\ 45000/-\ \&\ cost\ of\ old\ Motor\ is\ not\ given\ the\ annual\ cost\ old\ motor\ is: Rs.\ 29655.36$ $Pay\ back\ period = \frac{First\ cost}{annual\ savings}$ ---------- **(1 Mark)** $Pay\ back\ period = \frac{Rs.\ 45000}{Rs.\ 20160}$ Pay back period = 2.232 years ---------- **(1 Mark)** **OR** $First\ cost = Annual\ cost\ of\ old\ Motor: Rs.\ 29655.36$ $Pay\ back\ period = \frac{First\ cost}{annual\ savings}$ $Pay\ back\ period = \frac{Rs.\ 29655.36}{Rs.\ 20160}$ Pay back period = 1.471 years
Q.2	**Attempt any FOUR of the following : 16 Marks**
a)	**Describe how by replacing existing lamp sources with energy efficient lamp sources will improve efficiency.**
Ans:	**Explanation: (4 Mark)** While replacing the lamps by higher energy efficient ones we must ensure that the required color rendering (CRI) is maintained else it has an adverse effect on the quality & rate of the work output .Also the cost involved must also be considered.

	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) Replacement of Mercury/Sodium Vapour Lamp (around 50 to 75 lumens/W) by Halides Lamps. iv) Replacing HPMV Lamps (50 lumens/W) by High pressure sodium Vapour Lamp (HPSV) (150 lumens/W). v) Replacing filament lamps (10 to 15 W) on panels by LEDs (< 1 W). vi) Using LED lights in place of all other lamps above as feasible (in terms of cost)
b)	**State proper maintenance program for energy conservation in lighting system.**
Ans:	**Proper maintenance program for energy conservation in lighting system:** **(Any four point expected: 1 Mark each)** ➢ Illumination level reduces due to accumulation of dirt on lamps and luminaries. ➢ By carrying periodic survey & deciding/carrying the maintenance i.e. cleaning, dusting of lamps and luminaries will improve the light output / luminance. ➢ **Group relamping:** In this methods the all lamps are changed in the group whenever they are in use & attend 80% of there life & start decreases there illumination efficiency. It is the preventive maintenance. ➢ **Spot relamping:** It is the failure approach in which the lamps are changed immediately after their failure. ➢ As part of maintenance programme, periodic surveys of installation, lightning system with respect lamp positioning and illumination levels. ➢ Proper operation of control gears should be conducted to take advantage of energy conservation opportunities as user requirements changes. ➢ Use energy saving fluorescent lamps/LED lamps without disturbing the CRI. ➢ Use the recommended optimal level of illumination levels at different places. ➢ Sectionalize/group the load using proper switches by functional sections so that they can be switched on or off as per the requirements of the particular loads.

c)	**Describe constructional features of dry type transformer to improve efficiency.**

Ans:

Constructional features of dry type transformer to improve efficiency:

(Any point expected: 2 Mark each)

1. **Epoxy resin impregnated:**

In this transformer the polyster sealent is applied on transformer winding & the coils are poured in some chemical liquids & after it, it is dried in the oven. Due to this the winding resistance for corona will be increases but corona effect will be decreases. The high voltage sustained capacity will be increases. There will be more resistance to the moisture & due to epoxy resin impregnation there will be high temperature resistance. Due to all this point's losses in the transformer will be less & efficiency of the transformer will be increases.

2. **Cast resin impregnated:**

Basically the dialectical strength of these cast resin insulation is more than epoxy resin impregatition. It is equal to insulation level of transformer oil. The overload capacity of these transformers is more. The lighting surges caused due to any reasons will affect minimum for these cast resin transformer.

OR

1. Core used is of CRGO M4-M3 circular size therefore minimum 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.

d)	**Classify commercial losses in Transmission & Distribution system.**
Ans:	**Following are the commercial losses in transmission & distribution system**: **(Any four commercial losses expected: 1 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.
e)	**"Use of control gears and sensors helps in energy conservation in lighting system." — Justify.**
Ans:	**Use of control gears**: **(2 Mark)** 1. Flexibility can be obtained in lighting system by using following light control systems. It also saves power by switching off and by reducing luminance. 2. 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. 3. **Ballast:** It is the electrical or electronic chock which is commonly used in fluorescent tube or mercury vapour lamp. The main function of ballast is by applying the high voltage or high frequency across to the gas tube the light is emitted through the gas tube. At the time of supply voltage variation the current flowing through the discharge tube is maintained constant, so that light intensity on working plane will be maintained. 4. **Ignitor :** The ignitors are often called as starter or starting electrode. Generally ignitors are used in metal halide lamps or sodium vapour lamp. To increase the temperature surrounding the inner tube by current flowing initially after the temperature increases then full light will be emitted through these discharge tube. 5. **Illumination level:** As per the IES the lux level for every working plane is decided so these factors also used for control the lumens level on working plane.

	Sensor controlled controllers : **(2 Mark)** ➢ As a single control unit sensor 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.
f)	**A factory has an induction motor of 40 kW running with full load efficiency of 80%. It is supposed to be replaced by another motor having efficiency of 85%. What will be the saving in energy if motor work for 10,000 Hrs. per year and cost of energy is 5.00 per kWh ?**
Ans:	**Given data:** Motor output : 40 KW, full load efficiency : 80%, No. of Hrs = 10000 Hrs Cost of energy : Rs. 5/ KWh **Case I : full load efficiency : 80%,** Power drown by motor = $\frac{KW}{efficiency}$ Power drown by motor = $\frac{40}{0.8}$ Power drown by motor = 50 KW ---------- **(1/2 Mark)** Cost of energy consumed = power drown by motor x working hours x cost per unit Cost of energy consumed = 50 x 10000 x 5 Cost of energy consumed = Rs. 25,00,000/- ---------- **(1/2 Mark)** **Case II : full load efficiency : 85%,** **Power drown by motor** = $\frac{KW}{efficiency}$ Power drown by motor = $\frac{40}{0.85}$ Power drown by motor = 47.05 KW ---------- **(1 Mark)** **Cost of energy consumed** = power drown by motor x working hours x cost per unit

Cost of energy consumed = 47.05 x 10000 x 5

Cost of energy consumed = Rs. 23,52,500 ---------- **(1 Mark)**

Saving in energy per year = Case I - Case II

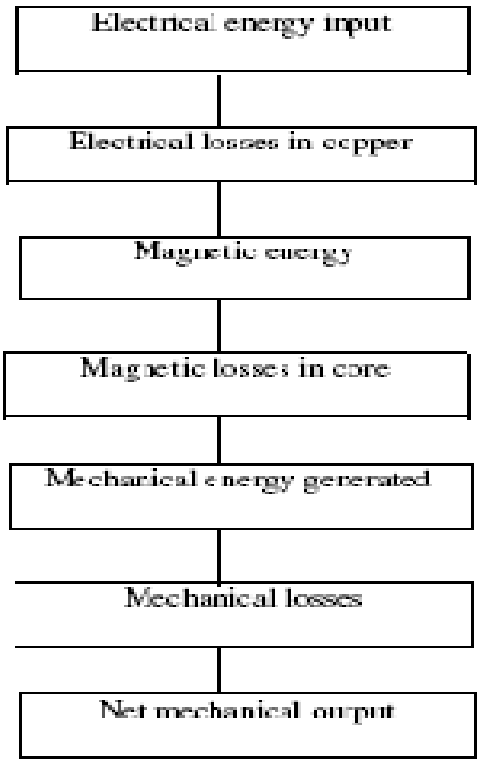
Saving in energy per year = Rs. 25,00,000 – Rs. 23,52,500

Saving in energy per year = Rs. 147500---------- **(1 Mark)**

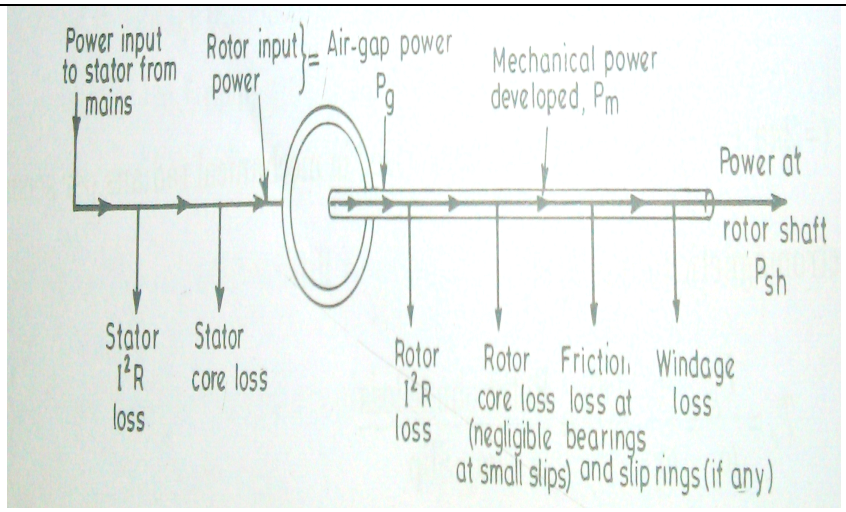
Q.3 **Attempt any FOUR of the following :** **16 Marks**

a) **Draw power flow diagram of induction motor and describe methods of improving efficiency by good power quality.**

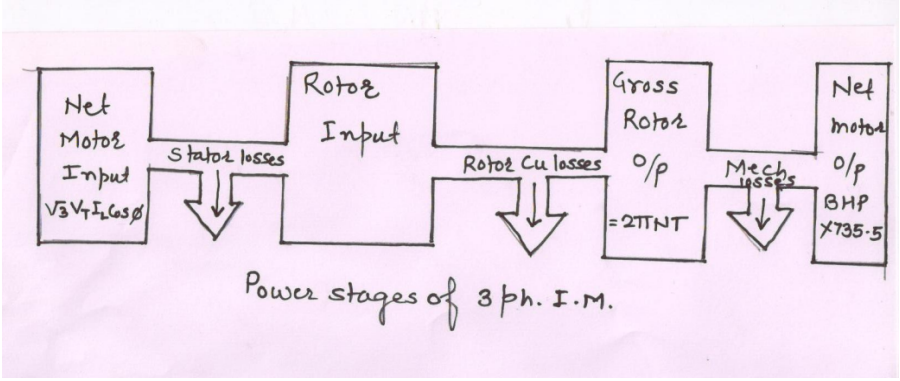
Ans: **Power flow diagram of induction motor: (Flow Diagram : 2 Marks & Methods: 2 Mark)**



OR



OR



Methods of improving power quality in it:-

1) Keeping 3-ph voltage constant
2) Balancing Phase current
3) By improving power factor
5) Voltage improvement and maintaining frequency at appropriate levels.
6) Increase power flow capacity.
7) Reduce losses.
8) Pollution free supply system.
9) Use quality anti friction bearings lubricants,
10) Use effective methods of cooling.

OR

	Power quality is defined by the closeness of the following to specified values: 1) Voltage 2) Frequency 3) Closeness of the supply to sine waveform [form factor = 7r/(2V2)], which also is a means for knowing the harmonic content of the supply. 1) **Voltage:** Maintaining the voltage at the rated value for motors results in the properly expected torque speed characteristics available to drive the load. Lower voltage leads to excessive current drawn due to which the line losses increase, machine copper losses increase, line voltage drops increase. Even if voltage is above required value higher flux density results in motors that leads to higher iron losses. These lead to decrease in efficiency. Hence proper voltage has to be maintained. 2) **Frequency:** It governs the speed related losses and iron losses. If its value is more than rated these losses increase as speed is directly proportional to the frequency the speed dependent friction & windage losses increase that will decrease the efficiency. Lower value of frequency leads to lower speed that affects the output power. Hence frequency has to be maintained at rated value. 3) When the supply waveform is purely sinusoidal the harmonics are absent which means no iron & copper losses due to harmonic voltage & currents. Also the harmonics even if very small lead to production of unwanted harmonic torques in motors which need to be overcome & this requires energy which is wasteful. Hence the supply voltage must be as near as possible to sine wave in case of AC motors.
b)	**List the advantages and disadvantages of amorphous core in transformer.**
Ans:	**Advantages of amorphous core in Transformer:** **(Any Two Advantages expected: 1 Mark each)** 1) Lowest hysteresis loss. 2) Low eddy current loss. 3) Low temperature rise

	4) Up to 75% energy saving using amorphous metal than conventional metal. 5) Reduced carbon dioxide emission. 6) Reduction in fossil fuel consumption. 7) Reduced magnetising current. 8) Better overload capacity. 9) High Reliability. 10) Excellent short circuit capacity. 11) Less maintenance cost. **Disadvantages of amorphous core in Transformer:** **(Any Two disadvantages expected: 1 Mark each)** 1) Small thickness of core stampings 2) Large core size. 3) Resistivity is 2 to 3 times more than silicon steel 4) Losses are 25 % more than CRGO 5) Flux density is less than CRGO 6) Large overall cost. 7) It can be used upto 10 MVA. 8) More insulating oil.
c)	**Explain following energy conservation methods of electrical motor: (i) Matching motor rating with required load. (ii) Minimizing idle & redundant running of load.**
Ans:	**(i) Matching motor rating with required load:** **(2 Marks)** ➢ The every motor is designed to perform any other electrical load or mechanical load and it is coupled together. ➢ The total capacity of these loads on the motor & the output rating of motor if is same than this motor is called as a best matching motor because these motor always works at maximum efficiency. **(ii) Minimizing idle & redundant running of load**: **(2 Mark)** 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 p.f. of such running is low leading to unnecessary losses

	line losses. 4) Reduction in overall system energy efficiency over period of time. 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 ➢ 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.
d)	**Describe energy conservation techniques for transformer related to change in material and design.**
Ans:	**Energy conservation techniques for transformer related to change in material and design:** **(Any four point expected: 1 Mark each)** ➢ Amorphous core transformer is energy efficient transformer. The magnetic core is made of amorphous metal. This core can be easily magnetized and demagnetized. ➢ The amorphous alloy is made up of iron boron silicon alloy molten metal mixture when cooled to solid state at a very high speed rate, retain a random atomic structure that is not crystalline. This amorphous resemble to glass so referred as glass metal. ➢ In case of amorphous core material size of core, conductor, tank and insulating oil is increases. ➢ The amorphous material is 9 times harder than CRGO steel. Hardness, along within small thickness makes slitting and shearing process more difficult. ➢ The amorphous material consists of high electrical resistivity and low field magnetization. Due to low field magnetization hysteresis loss is low. Due low electrical resistivity eddy current is suppressed. ➢ Hence overall cost of amorphous transformer is approximately 20 to 30 % costlier than conventional core transformer. ➢ by using super conducting material we can improve efficiency.

e)	**How power factor and load factor contributes technical losses in T & D system ?**
Ans:	**Power factor contributes technical losses in T & D system following reason:** **(Any four point expected: 1/2 Mark each)** 1. The power factor of the system depends upon the load. 2. The quality of load may differ. Due to this if the power factor is poor for the same connected load current flowing through the line will be increase. 3. To improve the power factor the shunt capacitors, phase advancer, synchronous condenser can be used. 4. Due to this reactive power flow is controlled hence technical loss is minimized. 5. Sometime s to control the reactive power flow the static VAR compensators & flexible AC transmission system (FACTS) are to be installed. 6. Due to this power factor improvements the energy losses in the line will be less. **Load factor contributes technical losses in T & D system following reason:** **(Any four point expected: 1/2 Mark each)** 1. When load factor will be improved average demand and maximum demand will be nearly equal and hence load fluctuation will be less 2. Due to less fluctuation the load system will work at higher efficiently. 3. Due to improved load factor there will be incentive in energy bill. 4. Due to improved load factor, reduces maximum demand. 5. The load factor will be economical to big industrial consumers because there load factor is more.
Q.4 (A)	**Attempt any THREE of the following : 12 Marks**
a)	**Describe Maximum Demand Tariff and Power Factor Tariff**
Ans:	**i) Maximum Demand Tariff:- (2 Marks)** ➢ It is similar to two part tariff except that maximum demand (KVA) is actually measured by installing maximum demand meter (in KVA) ➢ M.D. Meter (it is an electromagnetic or electronic trivector meter) is installed in the premises of consumer, in addition to energy meter. Maximum Demand Tariff / Load factor Tariff =

	$M.D.(KVA) \times Rs\ 'X'\ permonth + \{Number\ of\ units\ (KWH)\ Actual\ consumer\} \times Rs\ 'Y"$ ➢ If the any consumer crosses this limit of maximum demand then he has to pay additional penalty in is billing. **ii) Power Factor Tariff :** **(2 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.) than discount will be given in energy bill. ➢ As usual consumer has to pay actual energy consumption charges
b)	**Describe the need of cogeneration.**
Ans:	**Need for co-generation-** **(Any four point expected: 1 Mark each)** ➢ 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. Where as co-generation system produces both electrical energy & thermal energy from same flues. ➢ The overall efficiency of energy use in co-generation can be up to 85% and above. ➢ Lower volumes of CO_2 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 are lowered. ➢ Limited need of cooling water in co-generation system therefore reduces thermal pollution.

c)	**If minimum demand of consumer is 500 kW, p.f 0.8 lag and load factor 70%. The tariff applied is 80/ kVA of maximum demand and 20 paise per kWh consumed. Calculate annual bill of consumer.**
Ans:	**Given Data:** MD =500 kw P.f = 0.8 lagging load factor = 70% = 0.7 Tariff rate = R_S. 80 / KVA, Energy cost = Rs. 20 paise /Kwh 1. Units consumed /year: Max. Demand x L.F. x Hrs in years---------- **(1/2 Mark)** = (500) x (0.7) x (8760) = 30.66 x 10^5 Kwh---------- **(1 Mark)** 2. Max. Demand in KVA = 500/p.f. = 500/0.8 = 625 KVA ---------- **(1 Mark)** 3. Annual Bill = Max. Demand charges + Energy charges ---------- **(1/2 Mark)** = (625 x 80) + (20/100 x 30.66 x 10^5) Annual Bill = Rs. 663200/- ---------- **(1 Mark)**
d)	**Describe how load factor can contribute in reducing energy bill.**
Ans:	**Load factor can contribute in reducing energy bill following reason :** **(Any four point expected: 1 Mark each)** ➢ 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 I% ➢ 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.
Q.4 (B)	**Attempt any ONE of the following : 06 Marks**
a)	**Describe methods of reducing technical losses in transmission & distribution system.**
Ans:	**Methods of reducing technical losses in transmission & distribution system**: **(Any Six point expected : 1 Mark each)** ➢ Find out the weakest area of more technical loss in the distribution system. ➢ The distribution transformer should be always located near to the load centre. ➢ The capacity of the distribution transformer should be less. ➢ Reduce the overload on the distribution transformer & if require install one more additional transformer.

- Use energy efficient transformer in which amorphous core material is used.
- Shunt capacitor can be used to reduce the reactive power.
- Using the HVDC system for long distance transmission.
- Using the ACSR/AAAC/Bundle conductor instead of solid conductor.
- By regulating the system voltage.
- By reactive power compensation.
- By power factor controlling.
- By minimizing I^2R losses.
- By Balancing load current

OR

1. **Short term measures:-** **(3 Marks)**

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.

2. **Long term measures:-** **(3 Marks)**

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.

b) Describe features of (i) Block rate Tariff (ii) Two part Tariff.

Ans: **(i) Block rate Tariff :** **(3 Marks)**

- In case of block rate tariff there are blocks of units consumed and each block tariff rate/unit (KWH) is different plus consumer has to pay fix charges e.g.
- If generation is less than utilization than tariff rate/unit in each block goes on increasing and vice versa. e.g.

OR

- This is one of the better tariff as compare to other tariff. To decide the per unit cost the

fixed charge & variable charge is taken into account.

- The fixed charge is directly proportional to the connected load or maximum demand of the consumer. It is fixed always.
- The variable charges are directly proportional to the actual units consumed by the consumer as per the block rate tariff.
- This tariff system is commonly implement for residential & commercial consumers.
- It is the advantages to consumers & supply company also.

(ii) Two part Tariff: **(3 Marks)**

- In this type of tariff energy bill is split into two parts.

ENERGY BILL= FIXED CHARGE which depends on load (KW) + RUNNING CHARGE which depends on actual energy consume (KWH)

- Fixed charge which depends on load (KW) which is declared by consumer on test report.
- There is no separate meter is installed to measure load.
- Only one energy meter is used to measure number of units consumed.
- This type of tariff system is used for residential and commercial consumers.(up to 20 KW)
- This type of tariff is not used for industrial consumers.

OR

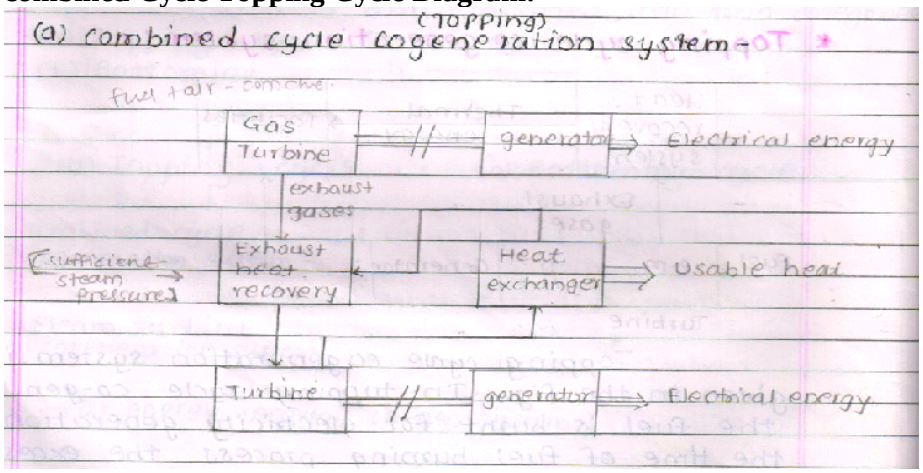
- To decide these tariff the all types of fixed charges, variable charges & semi fixed charges are taken into account.
- The fixed charges & variable charges are similar to two part tariff but semi fixed charges are depends upon the maximum demand, the power factor of the load etc
- To decide the semi fixed charges, the load factor, the plant capacity factor, the power factor & diversity factor is also considered.
- If there are more losses to the consumer side there will be penalty to him & if there are less losses it will be incentive to him in the semi fixed charges.
- This tariff system is applicable for large commercial load consumers & industrial consumers.

Q.5	Attempt any FOUR of the following : 16 Marks
a)	**Describe the methods of reducing commercial losses in distribution system.**
Ans:	**The methods of reducing commercial losses in distribution system: (4 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.

OR Student may write this way (Any four point expected)

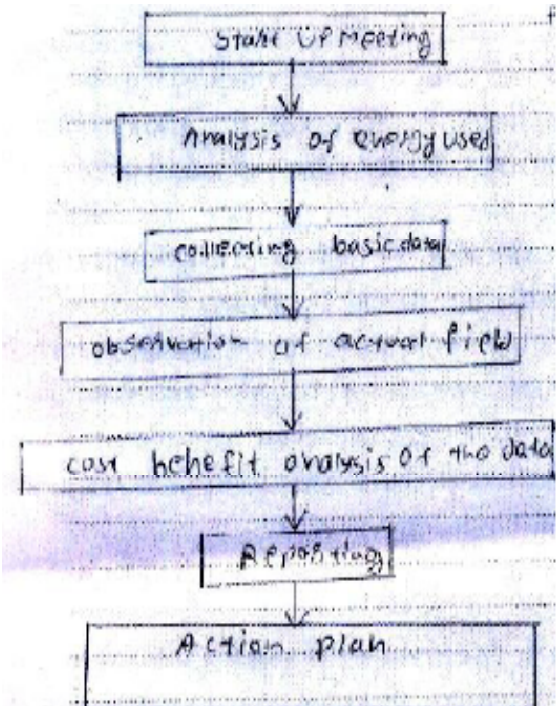
- Provide 100% metering: If the meter is faculty replace it immediately. If the consumers are not paying the bills then disconnect the supply immediately or used pre paid energy meter.
- Apply the electronics or static meters to every consumer.
- If the consumers P.f. is very poor then apply the penalty to him & suggest him use of P.f. improvement capacitors. If the P.f. is maintained by him give incentive in his billing.
- Always use small size of distribution transformers near to high density load area. In these way the technical loss will be less & energy theft will be also checked due to small premises.
- Always use the effective management or apply the demand side energy management.
- If there are so many connected loads which are inducing power system harmonics & due to these power quality is poor then apply the penalty to this consumers & suggest them use of power system harmonics filter.
- The total energy accounting & auditing is to be done by responsible persons time to time & corrective actions are to be taken.

b)	**Enlist various energy conservation equipments which can be implemented in lighting system and electric motors.**
Ans:	**1. Following energy conservation equipments which can be implemented in lighting system:** **(Any Two List expected: 1 Mark each)** 1.Voltage stabilizers 2. Dimmers 3. Microprocessor based centralized control equipment 4.Occupacy Sensor 5. Servo-stabilizer **2. Energy conservation equipments which can be implemented in electric motors:** **(Any Two expected: 1 Mark each)** 1. Soft starter: 2. Variable Frequency Drive (V.F.D) 3. Power Factor Controller Equipments
c)	**Describe combined Cycle Topping Cycle scheme of cogeneration with neat diagram.**
Ans:	**(Figure : 2 Mark & Explanation: 2 Mark)** **combined Cycle Topping Cycle Diagram:**  **or equivalent fig** **Explanation:** The combined cycle topping system is as shown in above fig. In this system the fuel & air is burnt in the combustion chamber for e.g. diesel or gas engine by which mechanical energy is obtained & it is coupled to the generator so in first stage electrical energy is generated. But in next stage the exust gases are passed through the exhaust heat boiler which

	generates sufficient steam pressure to drive secondary steam turbine which is coupled to the generator by which electrical energy is obtained in next stage also. In later stage the steam output from the turbine is provide to the heat exchanger to produce the usable heat.
d)	**State the benefits of variable frequency drives.**
Ans:	**Following are the benefits of variable frequency drive:** **(Any Four benefits expected: 1 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
e)	**State advantages of soft starters over conventional starters.**
Ans:	**Advantages of soft starters over conventional starters.** **(Any Four advantages expected: 1 Mark each)** 1) Motor starts (without jerk) smoothly. 2) Severe spikes of starting currents are eliminated. 3) Loss of energy during starting is minimized to about 40 to 50%. 4) Severe wear and tear of mechanical parts suchas bearing etc. during starting is eliminated leading to longer life of bearings and other related components. 5) Very low mechanical stress. 6) As starting currents are highly inductively limiting their magnitudes results in improved power factor. 7) As current peaks are controlled the MD is reduced which may lead to lower MD billing. 8) Less mechanical maintenance. 9) Saving in operating costs.

f)	**What is occupancy sensor? How it can be used as energy conservation equipments in lighting system?**
Ans:	**Occupancy sensor:** **(2 Mark)** ➢ Occupancy sensor is the very effective energy conservation tool which is widely used in energy conservation technique of lighting methods. ➢ Occupancy sensor senses the actual percentage of public coverage and according to that light is controlled. **Reason for it is used as energy conservation equipments in lighting system:** **(2 Mark)** ➢ In the high density population zone (in the public or commercial premises) the percentage of occupancy of the area which is covered by the public are sensed by the occupancy sensor and according to it the number of lighting devices are made on automatically for better energy conservation.
Q.6	**Attempt any FOUR of the following :** **16 Marks**
a)	**What is ABC analysis? State its advantages for energy audit.**
Ans:	**Definition:-** **(2 Marks)** ➢ ABC analysis provides a mechanism for identifying different categories of activities/stocks/items that will require different management and controls. ➢ "A class inventory" contains items that account for 70% of total value. ➢ "B class inventory" contains items that account for 20% of total value. ➢ "C class inventory" contains items that account for 10% of total value. ➢ ABC analysis is the material management technique which helps energy audit process to achieve the goal of energy audit. **Advantages referred to energy audit:** **(Any Two advantages expected: 1 Mark each)** 1) The audit helps to identify items and the costs of energies involved there in. 2) Schedule the different processes to achieve overall maximum useful Any three = output using the minimum inputs without losses of quality. 3) Optimize the expenses on energy required. 4) Maximize the savings. 5) Reduce energy losses. 6) improved efficiency.

b)	**Describe detailed energy audit procedure to be carried out for an organization.**
Ans:	**Detailed energy audit procedure Depending:** **(Figure : 2 Mark & explanation : 2 Mark)**



A) **Start up meeting**: For this programme , we proceed with this meeting. If then continue us until implementation of energy saving measures.

B) **Analysis of energy used**: Identify where energy used & it shows on which area should be concentrate.

C) **Collecting basic data:** At site load, some of the following important points:

1.Operating hours 2.Duty cycle 3.Actual power consume

D) **Observation of actual field**: After collecting data, we start actual field work. It means we have find out process where energy saving can be done. Always apply the 80 by 20 rule. It means concentrate on opportunities that require 20% input & givens 80% of the saving.

E) **Cost benefit analysis of the data:** The energy conservation opportunities analysis should be in terms of cost of carrying out that project v/s the benefit that can be earned.

F) **Reporting:** We have to submit the detail report. Then we have to take sanction of that report from final Authority.

G) **Action plan**: In this all the measure steps must be included in the action plan for the proper implementation.

OR

1. **Collect information about the plan:**

In this information, the measured energy used, raw material required & components required for the plant are considered.

2. **Collect production process:**

In this process, the design the flowchart of production process, the schedule of operation & its time frame is also considered.

3. **Energy and utility system**:

In this step, load variation in pumps, fans & compressors are considered, the analysis of energy loss and measurement of insulation level is also considered.

4. **Bridge description of each utility**:

In this step, the electricity the steam, water, cooling water an compressed air is to be considered.

5. **Detailed process flow diagram:**

In this step the flow chart, the flow rate & boiler efficiency is to be considered.

6**. Energy efficiency in utility & process system**:

In this step, consider the following things i) specific energy consumption ii) furnace iii) DG set performance analysis iv) lighting system.

7**. Energy conservation option & recommendation:**

The energy conservation & recommendation of better energy source is to be considered.

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

1) Depending on the nature and complexity of the organization, a comprehensive audit can take from several weeks to several months to complete.

2) Detail studies to establish and investigate energy & materials balances for specific organization departments of process equipment are carried out.

3) Whenever possible checks of organization operations are carried out over extended periods of

time at nights and at weekends.

4) The audit report will include a description of energy inputs and product outputs by major departments & will evaluate the efficiency of each step of the manufacturing process.

5) The improve this efficiency will be listed and at least a preliminary assessments of the cost of the improvement will be made to indicate the expected payback on any capital investment needed.

6) The audit report should conclude with specific recommendations for detailed engineering studies & feasibility analysis which must be performed to justify the implementation of those conservation measures that require investments.

c) State the factors to be considered for selection of cogeneration techniques.

Ans: **Following are the factors to be considered for selection of co-generation techniques:**

(Any Four factor expected: 1 Mark each)

1. Heat power ratio should match the characteristics of cogeneration system.
2. Load pattern: for selection of cogeneration system the type of load, its continuity is very important aspect so that we have to consider it.
3. The type of fuel: Generally the type of fuel is selected according to cost. The cost of fuel should be less.
4. The quality of thermal energy: The quality of steam is decided by temperature & pressure of the steam. It should be very good. (very high)
5. Electricity buyback: Sometime the electrical energy generated in cogeneration system is selled out to supply company, after that whenever that factory is need of electrical power. It is purchased from supply Company by common electricity buyback agreement.
6. Grid dependent & independent system technology: There are various technology systems applicable for grid dependent & independent. We have to consider this technology also.
7. Local environment regulations: In this regulation for cogeneration system we have to study all environmental conditions, politics & other regulation factors also.
8. Base electrical load matching: By cogeneration system the minimum electricity demand should be supplied.
9. Electricity load matching: It is the stand alone system or it is totally independent system

in which the 100% electrical energy is achieved by the cogeneration system.

10. Base thermal load matching: The minimum thermal energy can be achieved by our cogeneration system & if required for additional thermal energy can be generated from purchased power of supply company or grid system.
11. Thermal Load matching: In these system the 100% thermal energy is achieved by cogeneration system.

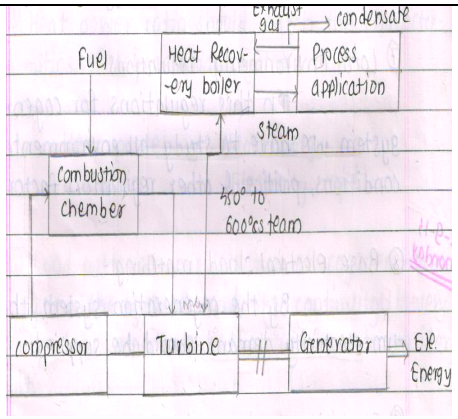
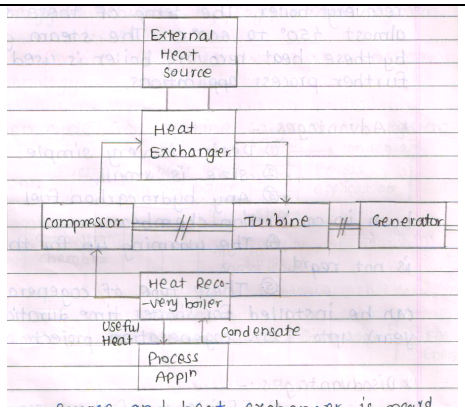
OR

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.

d) Distinguish between open cycle and close cycle gas turbine cogeneration system.

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

S.No	Open cycle gas turbine	Close cycle gas turbine
1	Design is very simple	Design is very complicated
2	Size is small	Size is not small.
3	Any hydrocarbon fuel can be burn in combustion chamber	Any hydrocarbon fuel cannot be burn directly in the combustion chamber. The helium or air is circulated for compression & expansion
4	The cost of the project is less.	The cost of the project is more
5	These type of cogeneration system can be installed for shorter time duration (within year) upto 7MW cogeneration	These type of cogeneration system can be installation period is very high (4 to 5 years). The cogeneration capacity is high upto 25 MW
6	Efficiency of the system continuously	Efficiency for the closed cycle gas

	varies	turbine is near about 30 % & it is higher than open cycle gas turbine
7	At part load application efficiency of cogeneration system	Part load operation does not a affect the efficiency
8	Life is less	The life of the cogeneration system is very high. It is almost 20 years
9		

e) Develop a questionnaire for energy audit of a multispeciality hospital.

Ans: **Following are the questionnaire for energy audit of a multispeciality hospital:**

(Any eight questionnaire are expected : 1/2 each)

What are the

1. Types of load?
2. Rating of transformer (KVA rating)?
3. Type of compressor?
4. KW load?
5. Current rating?
6. Voltage rating.?
7. Supply frequency?
8. Numbers of hours for consumers?
9. Capacitor types?
10. Type of transformer?
11. Stand by generator?

----------**END**----------