DIPLOMA BOARD EXAMINATION – OCT 2024

ANSWER KEY FOR THE QUESTION CODE -1837

SUBJECT CODE / NAME: 4030630 – ENERGY CONSERVATION AND AUDIT

BRANCH: EEE SEMESTER: 6 MAXIMUM MARKS: 100

PART-A

1. Give the benefits of star labelling. (3MARKS)

(Any three points)

- It helps to encourage the consumers to buy appliances and equipment's which are more energy efficient.
- If helps to provide products for customer choice. It helps to attract and retain the customers.
- More stars mean more saving on electricity bill.
- Demand of the labelled equipment's encourages the manufactures to produce more energy efficient equipment's in the market.

2. What is meant by secondary energy? Give an example. (3MARKS)

- Energy that can be manufactured using primary energy is called-secondary energy.
- Examples of secondary energy are steam, electricity, petroleum products, manufactured solid fuels and gases etc.

3. What is meant by rewinding of motor? (3MARKS)

- In industries rewind the burn out motors and reuse them. Hence the cost of new motor purchase is saved. Careful rewinding of motors sometimes maintains the motor efficiency at previous levels.
- But in most cases efficiency will be reduced. The efficiency of rewinding motor will be reduced due to the factors such as winding and slot design, winding material, insulation performance and operating temperature.

4. List out the advantages of energy efficient transformers. (3MARKS)

- In any transformer the iron loss depends on the type of core used. In latest technology, amorphous material- (a metallic glass alloy) is used for the core. By using epoxy resin cast/encapsulated dry type transformers efficiency improves to 93 to 97%.
- By using amorphous core, the transformers have increased efficiency of 98.5% even at low loads. By using energy efficient transformers, efficiency improves from 95% to 97%.
- Amorphous transformer is a modern example of energy efficient transformer. By using amorphous transformers efficiency improves to 97 to 98.5%.

5. Write the remedies adopted for commercial losses. (3MARKS)

(Any three points)

- A special vigilance squad should be set up to check and prevent theft of energy.
- Those who tamper the meter and broke the seals of meters should be punished and penalized. Energy audits should be conducted for each area so that theft areas can be detected and proper steps taken to prevent theft.
- Area officers should take the responsibilities for energy received and energy sales for a particular area.
- Energy meter should be installed in a tamper proof meter boxes and they should be sealed with tamper proof numbered seals.
- Install electronic meters which can not be tampered easily.
- Quality meter testing facilities should be provided to officers who carry out checking
- Faulty meters should be replaced with proper meters with seals immediately.
- Install meters at all transformers and consumers. Hence one can easily detect theft by comparing the figures Meter also helps to find out the losses,
- Installed meters should be checked periodically for the purpose of accuracy.

6. Write a note on electronic regulators. (3MARKS)

- An electronic regulator is an electronic circuit or device that regulates the output of a power source by controlling the flow of electrical energy to maintain a desired voltage, current, or power level.
- Replace conventional regulators with electronic regulators for ceiling fans.
- They can save 15-20% of energy.

7. List out the needs of energy audit. (3MARKS)

(Any three points)

- It helps to understand different ways of energy and fuels which are used in the industry.
- It helps to find different areas where a lot of wastes occur and find the scope for reduce waste.
- To reduce product cost.
- To reduce pollution.
- It gives energy cost reduction.
- It suggests quality control.
- It suggests preventive maintenance to reduce overall cost and save time.
- It ideates energy conservation technologies and energy conservation equipments.

8. State any three instruments used in energy audit procedure with their functions.

(Note: Here given all the instruments and their function) **(3MARKS)**

- Absolute pressure manometer -For low absolute pressure
- Diaphragm gauge - For low absolute pressure.
- Barometer-For atmospheric pressure
- Mano meter-For medium pressure differential
- Micro manometer -For very low-pressure differential
- Draft gauge-For low pressure differential
- Bourdon tube-For medium and high-pressure differential
- Pressure transducer- For remote measurement of rapidly changing pressure.

Ammeter (AC and DC)

Ammeters are used to measure the current in the electrical circuit. Clamp on ammeters is used to measure the currents in different sections or branches of the electrical system.

Voltmeter

AC and DC voltmeters are used for measuring the voltages at different points in electric system.

Tri vector meters

Tri vector meters is used to measure the multiple quantities such as KW, KVAR, KVA.

Energy meters

It is used to measure the electrical energy supplied to load.

Power factor meter

Power factor meter measures the power factor of the electric load. It also determines the type of load used in the system. (Resistive, inductive, capacitive)

Multi meter

It is a testing instrument used to measure two more electrical quantities. Voltage (AC and DC), current (ACand DC) Resistance (R).

Frequency meter

It is used to measure the frequency (Hertz) of the AC supply

Power Analyser.

An on-line power analyser gives a continuous measurement and record of real power (Kl), apparent power (KVA), voltage, current and power factor.

1. Synergy meter:

This instrument measures and records current, voltage, power factor, frequency, kWh and KVAh.

2. ph meter

It is used to measure the pH value of solutions to give the idea of their corrosions, pollution capacity etc.

3. Wattmeter

A wattmeter is an electrical instrument used to measure the electrical power in watts consumed by an electrical circuit or produced by a generator. It typically consists of a current coil and a voltage coil, which together measure both the current flowing through the circuit and the voltage across it to calculate power.

4. Flue Gas Analysis

Combustion gas analyzer is used to measure various combustion gases such as CO2, O2, CO2, NO2, SO2, etc. This analyzer has in-built chemical cells which measure the combustion gases.

Specific sensors sealed inside the equipment can be changed to measure the different components in the gas. But only two or three parameters can be measured at one time because a maximum of two sensors can be connected to it.

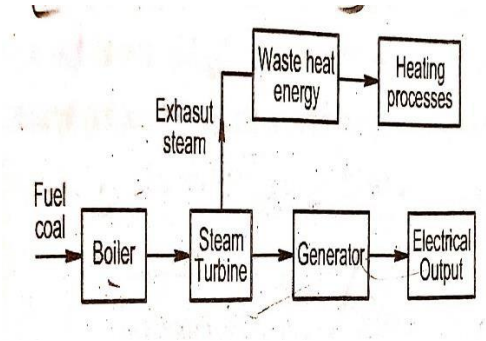
Temperature and Thermal loss measurements

- Thermal loss is the decrease of heat existing in space, resulting from heat transfer. Through roof, walls and windows.
- There are four types of heat losses within any building. These include thermal radiation, conduction, convection and air infiltration.
- The factors affecting thermal losses include wind speed, wind direction and ambient temperature**.**

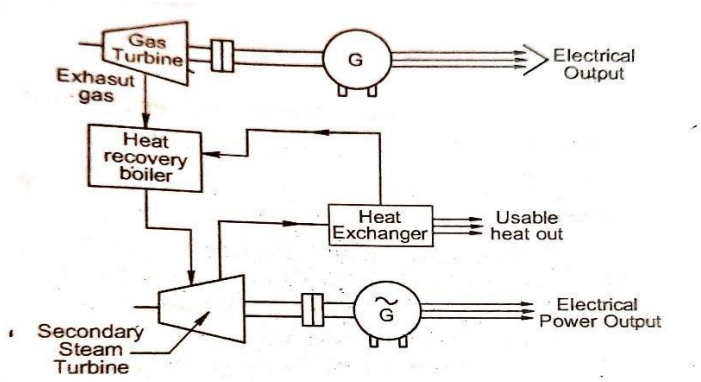
9. Draw the topping cycle of co-generation system. (3MARKS)

(Note:Any one diagram is enough)

(a)



(b)



10. Mention any three types of tariff. (3MARKS)

(NOTE:ALL THE TYPES ARE GIVEN)

- Simple tariff
- Flat rate tariff
- Block rate tariff
- Two-part Tariff

Special tariff

- Time-OFF day tariff
- Peak-OFF day tariff

Power factor tariff

- KVA maximum demand tariff
- sliding scale tariff
- KWh and KVAR tariff
- Maximum demand tariff
- Load factor tariff

PART-B

11.(a) Explain about the Safety rules for working with Electrical Equipments. (14 MARKS)

- Disconnect the power source before servicing or repairing electrical equipments.
- Use only tools and equipments with insulating handles when working on electricaldevices.
- Before replacing a blown out fuse always put the main switch off.
- Always keep the earth connection in good condition.
- Check proper working of safety devices. Avoid contact with energized electrical circuits.
- When working on electrical equipment, be sure that the hands are dry and wear insulatedgloves, protective clothes and shoes with insulated soles.
- If water or chemical is spilled on the equipment, switch off the power supply. Never tryto remove water on the equipment while working.
- Enclose all electric contacts and conductors.
- Do not store highly flammable liquids near electrical equipment's.

(OR)

11.(b) Discuss about the various energy conservation techniques. (14 MARKS)

1. Energy conservation techniques in transformers

Energy conservation in transformer is done by different techniques like optimization of loading of transformer, improvisation in design and material of transformer, replacement by energy efficient transformers etc.

2. Energy conservation in transmission line

Line resistance is reduced by replacing standard conductors (ACSR or AAC) by bundled conductors in HT line. High voltage direct current (HVDC) is used to transmit larger amount of power. Energy conservation in transmission line can also be done by using reactive power controllers and transmission of energy at high voltage levels.

3. Energy conservation in distribution line

Energy conservation in distribution line can be achieved by optimization of distribution system, balancing of phase load, harmonics reduction, using power factor controller etc.

4. Energy conservation in lighting system

Energy conservation in lighting system is achieved by optimum use of natural light, replacing incandescent lamps by compact fluorescent lamp (CFLS), replacing conventional fluorescent lamp by energy efficient fluorescent lamp, replacement of conventional ballast by electronic ballast, installation of separate transformer for lighting, installation of servo stabilizer for lighting feeder etc.

5. Energy conservation in motors

If we consider industrial applications almost 70% of total energy is consumed by only electric motor driven equipment.

12. (a) Explain the energy conservation techniques to be adopted to reduce losses in induction motor. (14 MARKS)

- Improving power quality

1. Harmonic Filters: Install harmonic filters to reduce harmonic distortion.

2. Voltage Regulators: Use voltage regulators to regulate voltage and prevent sags and swells.

3. Power Factor Correction (PFC): Install PFC devices to improve power factor and reduce harmonic distortion.

4. Motor Drive Systems: Use motor drive systems with built-in power quality improvement features.

5. Regular Maintenance: Regularly maintain motors to prevent premature failure and reduce the effects of poor power quality.

- Motor survey

1. Energy Savings: Identify opportunities to reduce energy consumption and costs.
2. Improved Motor Performance: Optimize motor performance, reducing downtime and increasing productivity.
3. Extended Motor Life: Proactively maintain and replace motors, extending their lifespan and reducing maintenance costs.
4. Compliance with Regulations: Ensure compliance with energy efficiency regulations and standards.

- Matching motor with loading

1. Torque Matching: Ensure the motor's torque output matches the load's torque requirements.
2. Speed Matching: Ensure the motor's speed range matches the load's speed requirements.
3. Power Matching: Ensure the motor's power output matches the load's power requirements.
4. Efficiency Matching: Choose a motor with high efficiency to minimize energy losses.

- Minimizing the idle and redundant running of motor.

1. Implement Motor Control Strategies: Implement motor control strategies, such as:
   Start/Stop Control: Start and stop motors only when necessary.
   Speed Control: Adjust motor speed to match changing load conditions.
2. Use Sensors and Monitoring Systems: Install sensors and monitoring systems to track motor performance and detect opportunities for energy savings.
3. Optimize Motor Operating Schedules: Optimize motor operating schedules to minimize redundant running, such as:
   Scheduling: Schedule motor operation to coincide with periods of high demand.
   Load Shedding: Shed non-essential loads during periods of low demand.
4. Implement Energy Management Systems: Implement energy management systems to monitor and control

- Operating in star mode.

  1. Reduced Voltage Stress: Star mode operation reduces the voltage stress on the motor windings, as the phase voltage is lower than the line voltage.
  2. Improved Power Factor: Star mode operation typically results in a higher power factor, as the motor operates closer to its designed power factor.
  3. Reduced Harmonic Distortion: Star mode operation can reduce harmonic distortion, as the motor operates with a more balanced three-phase voltage.
  4. Increased Motor Efficiency: Star mode operation can result in increased motor efficiency, as the motor operates closer to its designed efficiency.

- Rewinding of motor
- Replacement by energy efficient motor
- Periodic maintenance
- Improving mechanical power and transmission efficiency

(OR)

12. (b) Discuss how load sharing and parallel operation are used to conserve energy of a transformer. (14 MARKS)

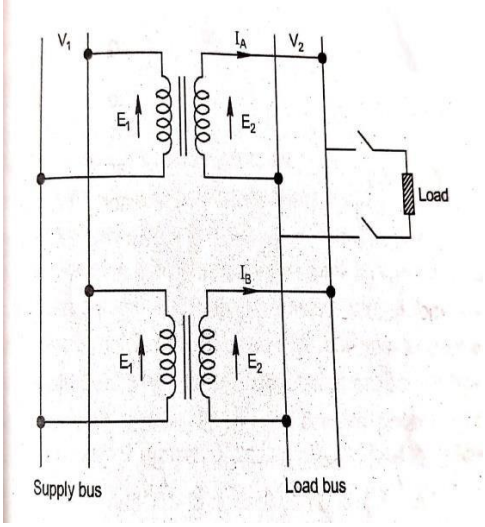
ENERGY CONSERVATION BY LOAD SHARING (7marks)

- The transformer operates throughout the day in the power supply system to feed the load connected to it. Many times it may happen that the load on the transformer is fluctuating and sometimes going beyond the capacity of the transformer and thereby overloading it.
- If such overloading is frequent, it may damage the insulation of transformer windings and leads to permanent failure.
- To avoid this the transformers are operated to share the load by operating several transformers in parallel mode.
- Hence the transformers work efficiently and damage is prevented. Thus, the reliability of supply is increased. Similarly, in this method the problem of supply interruption and overloading and overheating can be avoided.
- Load sharing means generally equally share the load in power system. In power systems, load sharing of the transformer is achieved with different techniques.
- That is if two transformers are available to connect to the load, then one transformer share the load in normal condition and if the load demand is increasing then the other transformer is connected in parallel with the first transformer to share the load.
- In power systems, when the load demand is more than the rating of the existing transformer, two or

more transformers may be connected in parallel with the existing transformer.

ENERGY CONSERVATION BY PARALLEL OPERATION OF TRANSFORMERS (7marks)

- The design of the Power Control Centre (PCC) of any new plant should have the provision of operating two or more transformers in parallel. Additional switch gears and bus couplers should be provided at the design stage.



- Whenever two transformers are operating in parallel both should be technically identical in all aspects and should have the same impedance level.
- This will minimise the circulating current between the transformers. Where the load is fluctuating in nature it is preferable to use more than one transformer connected in parallel for sharing the load.
- In this method, the transformers can be operated close to the maximum efficiency. Above figure shows the parallel operation of transformers.

13. (a) Discuss about optimizing distribution voltage to reduce technical losses.

(14 MARKS)

- On LT lines technical losses are higher, but it can be reduced by using HT lines upto the consumer end.
- In High Voltage Distribution System, a transformer is installed on the pole with distribution box below it and from this distribution box, consumers get supply.
- 12 consumers can be connected to one distribution box. In transmission system, rise in voltage improves the power transmission capacity.
- If voltage is increased 'n' times, then the size of the conductor reduces by 1/n2 times that of actual conductor size.

- On the other hand higher voltage involves higher cost of the system (cost of insulation, cost of switch gear, terminal apparatus etc).
- Thus there is an optimum voltage selected for a particular transmission system.
- The relation between capital cost in Rs and standard line voltage in KV can be plotted and we get parabolic curve. The lowest point on the curve represents optimum voltage to be chosen.

(OR)

13. (b) Write notes on (i) maximum demand controller (ii) KVAR controller.

(14 MARKS)

(i) Maximum demand controller **(7 marks)**

- High Tension (HT) consumers have to pay a maximum demand charge in addition to the usual charge for the-number of units consumed.
- The charge is usually based on the highest amount of power used during some period (say 30 minutes) during the metering month. This charge often represents a large part of the total bill It may be based on only one 30 minutes of high-power usage Considerable savings can be achieved by controlling power use and turning off or reducing non-essential loads during such periods of high-power use.
- Maximum Demand Controller is an energy efficient, electrical device helps in controlling the KW demand during high power usage periods by switching off the non-essential loads. Alarm is sounded when maximum demand approaches to a pre-set value.
- If corrective action is not taken the controller switch off the non-essential loads in a logical sequence. This sequence is predetermined and programmed by the user. The plant equipment's selected for the load management are stopped and restarted as per the desired load profile Demand control scheme is implemented by using suitable control contactors.

(ii) KVAR controller **(7 marks)**

- Power factor of an AC electrical power system is defined as the ratio of the real power (KW) to the apparent power (KVA) absorbed by the load (ie.cosω = KW/ KVA)
- In industries majority of the load is inductive due to presence of induction motors and transformers. Hence the power factor of load is lagging.
- To improve the lagging power factor of the load a capacitor is connected across the inductive load. The correct capacitor will minimize the load current and at the same time bringing the power factor to unity without changing the real power (KW) KVAR controller is used for this purpose KVAR controller reduces the consumers energy bill by correcting the power factor to unity.

- Improved power factor increases the life of electrical devices, help motors run more efficiently, etc. KVAR is controlled by micro controller and contactor arrangement. Power factor of the load is sensed and capacitors are connected or disconnected on the basis of KVAR demand. Maintaining the power factor at unity leads to reduction of current in the lines.
- The supply main terminals are connected to the input of the KVAR controller panel Power factor is sensed by the CT and PT As per the requirement, the capacitor banks are operated to achieve the required power factor by microprocessor based relay automatically.

14. (a) Explain how energy audit is carried out in HVAC system and water heating system. (14 MARKS)

- HVAC stands for Heating Ventilation and Air Conditioning. HVAC audit is performed to make things work properly and efficiently.
- HVAC audits are all about minimising the energy loss and maximising the efficiency.

There are three different types of HVAC energy audits.

- Level 1 audit
- Level 2 audit
- Level 3 audit

Level 1 audit

This is the most basic audit level. In this level, the energy auditor collects data about the building system's operations by a high-level walk through, reviewing, recent utility bills and interviewing operation personals. Level 1 audit will help us to identify any major problems in the HVAC systems.

Level 2 audit

This is a most in-depth version of level 1 audit. Level 1 audit is about examining the current system's performance, and Level 2 is improving the performance. The auditor does complicated calculations to determine where the energy efficiency can be improved.

Level 3 audit

This is the most complex type of audit. The energy auditor will do in-depth engineering analysis of what the changes would look like if implemented them in the buildings HVAC system. It helps to find the energy systems future, if level 2's improvements are implemented.

WATER HEATING SYSTEM

Water heating systems generally consume less energy than air conditioning and lighting. At the same time some cases like hospitals, restaurants, kitchens and laundries where water heating consumes more energy.

Water heating energy is conserved by reducing load requirements, reducing distribution losses, and improving the efficiency of the water heating systems.

(OR)

14. (b) Discuss about the basic measurements in energy audit. (14 MARKS)

(NOTE:ALL THE TYPES ARE GIVEN ,EACH TYPE CARRIES 2 MARKS .THEY HAVE TO WRITE ANY SEVEN OUT OF THIS)

Electrical Measurements

The basic electrical parameters in AC and DC systems are Voltage (V), Current (1), Power factor (cosφ), Active power (KW), Apparent power (KVA), Reactive power (KVAR), Energy consumption (KWh), Frequency (Hz) etc.

Non electrical Measurements

Non electrical measurements are pressure, temperature, heat flow, air and gas flow, radiation, revolution per minute (rpm), liquid flow, noise and vibration etc.

The following format is applicable for most of the industries.

Light Measuring Instrument

Lux meter is used to measure the illumination level.

It consists of photo cell. Photo cell senses the light output and converts the light into electric pulses which are calibrated as lux.

Pressure measuring instruments

1. Absolute pressure manometer -For low absolute pressure
2. Diaphragm gauge - For low absolute pressure.
3. Barometer-For atmospheric pressure
4. Mano meter-For medium pressure differential
5. Micro manometer -For very low-pressure differential
6. Draft gauge-For low pressure differential
7. Bourdon tube-For medium and high-pressure differential
8. Pressure transducer- For remote measurement of rapidly changing pressure.

TEMPERATURE MEASURING INSTRUMENT

1. Glass Stem Thermometer

Mercury or alcohol in glass are used for temperature measurement of gas, air and liquids in the range of 20 to500°C.

2. Contact Thermometer

Contact thermometers are thermocouples which measure the temperature of flue gas, hot air, hot water etc by insertionof probe into the steam. A leaf type probe is used in the same instrument for measurement of surface temperature.

3. Non-contact Infrared Thermometer

These are used to calculate the amount of thermal radiation (infrared radiation) emitted from the object. It consists of lens to fog us the infrared energy on to a detector.

The detector changes this energy into an electrical signal tai can be shown in temperature, It is also used to measure hat spots in furnaces, surface temperature etc.

HEAT FLUX MEASURING INSTRUMENT

Heat flux is defined as the rate of heat energy transfer through a given surface.

A heat flux sensor is an instrument used to measure that rate of heat energy transfer per unit area. It is a transducer which generates electrical signal (output voltage) which will be proportional to the measure of heat rate. The sensor is capable of measuring all three forms of heat transfer. The three forms of heat transfer are conduction, convection and radiation.

VIBRATION MEASURING INSTRUMENT

Vibration is the movement or mechanical oscillation about an equilibrium position of a machine.

Vibration sensors, meters and analysers are usually called vibrometers. These are the portable devices and based on accelerometer or laser technology. They measure the vibration level of a machine or its components.

The most common vibrometers are two types.

1) Vibrometers based on accelerometer
2) Laser vibrometer

Vibrometers based on accelerometer

This type of vibrometer measures both displacement and acceleration of the vibration. In this type the sensors are mounted on the machine.

Laser vibrometer

Laser vibrometer employ completely different technology. The operation consists of detecting and analysing laserradiation developed by the vibrating part of the machine.Here the phenomenon of Doppler effect is applied. That is when an object vibrates then the frequency of laser lightchanges and the speed of movement of the vibrating part is measured by the device.

VELOCOTY MEASURING INSTRUMENT

Pilot tube and Manometer

Pilot tube is used to measure the air velocity in ducts and inclined Manometer is used for further calculation of flows.

FLOW RATE MEASURING INSTRUMENT

Water Flow Meter

It is a non-contact flow measuring device using ultrasonic principle. These meters are classified as Transit time and Doppler.

Transit time ultrasonic meters have both sender and receiver. They send two ultrasonic signals across the pipe.

One signal travelling with the flow and other travelling against the flow. The ultrasonic signal travelling with the flow travels faster than that of travelling against the flow. Water flow meter measures the transit time of the both the signals. The difference between the transit time of both signals is proportional to the flow rate. These meters are mostly used to monitor the clean liquids.

Doppler ultrasonic flow meters compute flow rate. The flow rate is proportional to the frequency shift of the ultrasonic signals that reflect from the particles of the flow stream. These meters are used to monitor dirty liquids.

15. (a) Discuss about energy audit report format. (14 MARKS)

- After successfully being carried out the energy audit, energy auditor should report to the top management for effective implementation.
- A typical energy audit reporting contents and format are given below. The format can be suitably modified for specific requirement applicable for a particular type of industry.

The following format is applicable for most of the industries.

Report on detailed energy audit

Tables of contents

- Acknowledgement
- II. Energy Audit Team
- III. Executive Summary

Energy audit options and recommendations

Plant Introduction

1. General plant details and descriptions.
2. Production cost of component (Raw materials, energy, chemicals, manpower, overhead, others).
3. Major energy use and areas.

Description of Production Process

1. Brief description of manufacturing process.
2. Process flow diagram and major unit operations.
3. Major raw material inputs, quantity and costs.

Description of Energy and Utility System

1. List of utilities
2. Brief description of each utility

- Electricity
- Water
- Steam
- Compressed air
- Cooling Water

Detailed Process Flow diagram and Energy and Material Balance

1. Flow chart showing temperature, flow rate, pressure of all input-output stream.
2. Water balance for entire industry

Energy efficiency in utility and process systems

- Specific energy Consumption
- Boiler efficiency assessment
- Furnace efficiency analysis
- Cooling water system performance assessment
- Thermic fluid heater performance assessment
- DG set performance assessment
- Refrigeration system performance
- Compressed air system performance
- Electric motor load analysis
- Lighting System

Energy Conservation Options and Recommendations

1. List of energy conservation options in terms of no investment cost or low investment cost, medium investment cost and high investment cost, Annual energy and cost savings, payback calculations.

2. Implementation plan for energy saving projects

Annexure

1. List of energy audit worksheets
2. List of instruments
3. List of vendors and other technical details

The following tables can be used as a guidance for energy audit assessment and reporting.

Work sheets

Table 1

Summary of energy saving recommendations

S.No	Energy Saving Recommendations	Annual energy savings (Fuel and Electricity) (kWh/MT) or (kL/MT)	Annual Cost Savings (Rs.Lakhs)	Capital Investment (Rs.Lakhs)	Simple payback period
1					
2					
3					
4					
Total					

Note: kWh - KiloWatt hour, MT - Metric TON, KL - Kilo litre

Table 2

Types and Priority of Energy Saving Measures

S.No	Types of energy saving options	Annual electricity of fuel savings kWh/MT or kJ/MT	Annual Savings (Rs.Lakhs)	Priority
A	No Investment (Immediate) - Operational improvement - House keeping			
B	Low Investment (Short to medium term) - Controls - Equipment Modification - Process change			
C	High Investment (Long Term) - Energy efficient devices - Product modification - Technology change			

Table 3

Reporting Format for Energy Conservation Recommendations

1.	Title of Recommendation	Combine DG set cooling tower with main cooling tower
2.	Description of existing system and its operation	
3.	Description of proposed system and its operation	
4.	Energy Saving Calculations 1. Capacity of main cooling tower 2. Temperature across cooling tower (design) 3. Present capacity 4. Capacity of DG set cooling tower 5. Power drawn by the DG Set cooling tower 6. Number of pumps and its rating 7. Number of fans and its rating 8. Power consumption at 80% load 9. Additional power required 10. Net energy savings	
5.	Cost Benefits 1. Annual energy saving potential 2. Annual cost savings 3. Investment 4. Simple payback period	

(OR)

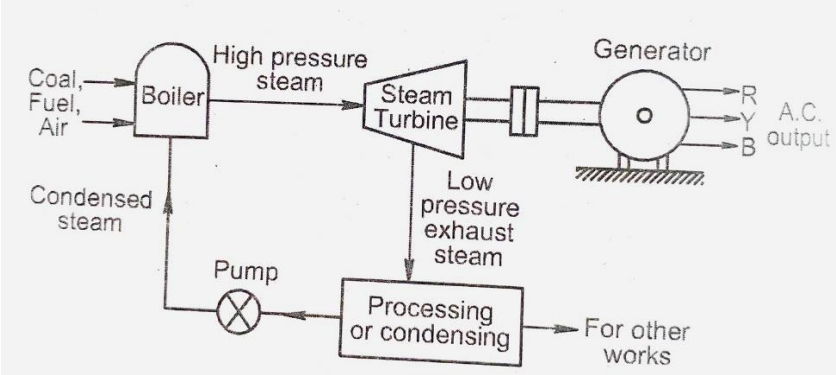
15. (b) Write the classification of co-generation systems based on technology. Explain any two. ***(ALL TYPES ARE GIVEN)*** **(14 MARKS)**

On the basis of technology, co-generation is classified as

1. Steam Turbine Co-generation system
2. Gas Turbine Co-generation system
3. Reciprocating Engine Co-generation system

Steam Turbine Co-generation system (DIAGRAM-4MARKS,THEORY-3MARKS)

Steam is a medium by which energy is converted into mechanical energy. The main equipment's are boiler, steam turbine, exhaust steam condenser, feed pump. The burning coal, heat the water in the boiler and produces high pressure steam. This steam drives the turbine which in turn drives the generator to produce electricity.

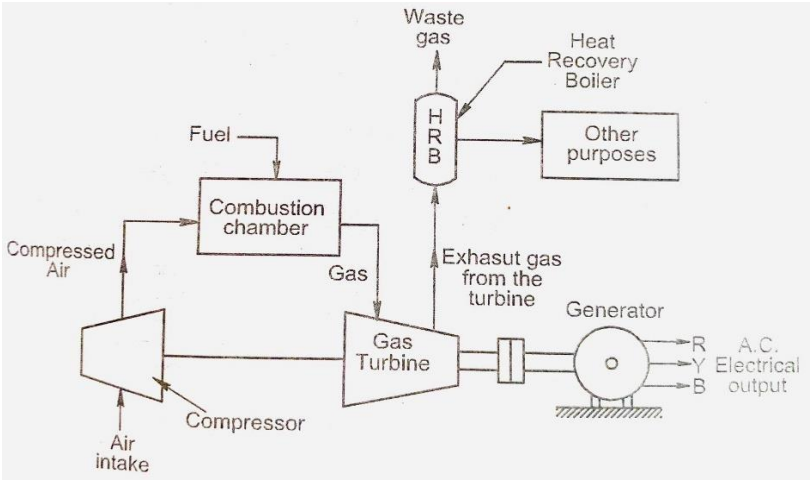


The exhaust steam from the turbine has low pressure which is condensed by the condenser or it may be taken out and used for other purposes. The condensed steam is fed back to the boiler.

Hence the efficiency of the plant increases.

Gas Turbine Co-Generation system (DIAGRAM-4MARKS,THEORY-3MARKS)

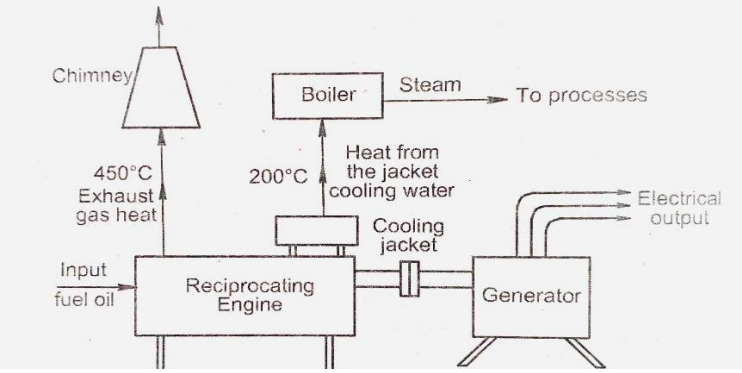
The working medium is the exhaust gas of combustion chamber. The main equipment's are air compressor, combustion chamber, gas turbine, generator, heat recovery boiler.



The compressed air from the compressor sent to the combustion chamber where fuel is fed and burnt to produce Sas at high pressure. The high-pressure gas is applied to the gas turbine which drives the generator to produce electricity.
The waste gas from the gas turbine is applied to heat recovery boiler and this heat is usefully used for other Purposes. Then from the heat recovery boiler, the gases are
liberated to the air.

Reciprocating Engine Co-Generation system (DIAGRAM-4MARKS,THEORY-3MARKS)

Reciprocating engine co-generation system is anoia.
technic of co-generation.
This system uses internal combustion engines to provide torque and heat with higher efficiency than the steam and gas turbine. There are two sources of heat for recovery.



They are exhaust gas at high temperature and engine jacket cooling water system at low temperature as shown in the above figure. The engine is coupled to the generator which produces electrical energy as output.
The exhaust gas from the engine and the heat from the engine jacket cooling water are fed to the boiler as shown in the above figure. The steam from the boiler is used for other
purposes.

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