SUMMER–18 EXAMINATION

Model Answer

Subject Name: Energy Management **Subject Code: 17559**

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. No.	Sub Q. N.	Answer	Marking Scheme
1	A	**Attempt any three of the following**	12
	a)	**Primary energy** is an energy form found in nature that has not been subjected to any conversion or transformation process. The primary energy sources are derived from: the sun, the earth's heat, the wind, water (rivers, lakes, tides, and oceans), fossil fuels - coal, oil, and natural gas, biomass, and radioactive minerals. **Secondary energy** Secondary energy refers to the more convenient forms of energy which are transformed from other, primary, energy sources through energy conversion processes. Examples are electricity, which is transformed from primary sources such as coal, raw oil, fuel oil, natural gas, wind, sun, streaming water, nuclear power, gasoline etc. **OR**	2
		Conventional Energy sources: These sources are exhaustible after use. e.g Coal, crude oil, Gas	2

		Non-Conventional energy sources: These sources can renew again and again. e.g Solar, Wind, Biomass, Hydro	
	b)	**Natural draft cooling towers** As their name implies, natural draft cooling towers rely on natural convection to circulate air throughout the tower, which then cools the water. Air movement occurs due to differences in density between the entering air and the internal air within the tower. Warm, moist air, which is more dense than cool air, will naturally rise through the tower, while the dry, cool air from outside will fall, creating a constant cycle of air flow. **Mechanical draft cooling towers** Unlike natural draft cooling towers, mechanical draft cooling towers employ fans or other mechanics to circulate air through the tower. Common fans used in these towers include propeller fans and centrifugal fans. Mechanical draft towers are more effective than natural draft towers, and can even be located inside a building when exhausted properly. However, they consume more power than natural draft cooling towers and cost more to operate as a result. Crossflow towers and counterflow towers are the two types of mechanical draft cooling towers: **Crossflow towers** In a crossflow tower, air flows horizontally through the cooling tower's structure while hot water flows downward from distribution basins. Crossflow towers can be as tall as counterflow towers, but they're also more prone to freezing and are less efficient. **Counterflow towers** Counterflow towers move air upward through the tower while water flows downward to cool the air. These towers are often more compact in footprint than crossflow towers, and can save energy in the long run.	1 1 1 1

	c)	**Specific heat**: The specific heat is the amount of heat per unit mass required to raise the temperature by one degree Celsius. **Calorific Value**: It is the amount of heat released during combustion of a unit quantity of fuel.	2+2
	d)	**Benchmarking** Benchmarking is the process of comparing one's business processes and performance metrics to industry bests or best practices from other companies. **Gross production related:** kWh/MT clinker or cement produced (cement plant) kWh/kg yarn produced (textile unit) kWh/MT , kcal/kg, paper produced (paper plant) kcal/kWh power produced (heat rate of power plant) million cal/MT urea or ammonia (fertilizer plant) kWh/MT of liquid metal output (in a foundry) **utility related :** kW/ ton of refrigeration (on air conditioning plant) % thermal efficiency of a boiler plant % cooling tower effectiveness in a cooling tower kWh/Nm^3 of compressed air generated kWh/liter in a diesel power generation plant	2 2 marks for any two examples
1	**B**	**Attempt any one of the following**	**6**
	a)	**Types of fuels with example based on physical state**	2 +2+2

		Solid fuels: Coal, Uranium, Wood Liquid fuel : Petroleum products (petrol, diesel, aviation fuel),biodiesel, ethanol Gaseous fuel : LPG, CNG, Biogas, Hydrogen	
	b)	**Power available in wind** The kinetic energy (**KE**) of an object (or collection of objects) with total mass **M** and velocity **V** is given by the expression: $$KE = 1/2\ M\ V^2$$ Now, for purposes of finding the kinetic energy of moving air molecules (i.e.:wind), let's say one has a large air parcel with the shape of a huge hockey puck: that is, it has the geometry of a collection of air molecules passing though the plane of a wind turbine's blades (which sweep out a cross-sectional area **A**), with thickness (**D**) passing through the plane over a given time. The volume (**Vol**) of this parcel is determined by the parcel's area multiplied by its thickness: $$Vol = A\ D$$ Let ρ (the greek letter 'rho') represent the density of the air in this parcel. Note that density is mass per volume and is expressed as: $$\rho = M / Vol$$ and a little algebra gives: $M = \rho\ Vol$ Now let's consider how the velocity (**V**) of our air parcel can be expressed. If a time **T** is required for this parcel (of thickness **D**) to move through the plane of the wind turbine blades, then the parcel's velocity can be expressed as $$V = D / T,$$ and a little algebra gives $$D = V\ T$$ Let's make some substitutions in expression no. 1 **($KE = 1/2\ M\ V^2$)** Substitute for **M (= ρ Vol)** to obtain:	6

		$KE = 1/2 (\rho\ Vol) V^2$ And **Vol** can be replaced by **A D** to give: $KE = 1/2 (\rho\ A\ D) V^2$ And **D** can be replaced by **V * T** to give**:** $KE = 1/2 (\rho\ A\ V\ T) V^2$ Leaving us with: $KE = 1/2\ \rho\ V^3\ A\ T$ Now, **power** is just energy divided by time, so the power available from our air parcel can be expressed as : $P = KE / T$ $= (1/2\ \rho\ V^3\ A\ T) / T$ $P = 1/2\ \rho\ V^3\ A$	
2		**Attempt any four of the following**	**16**
	a	**Energy saving opportunities in cooling tower (any four)** • Follow manufacturer's recommended clearances around cooling towers and relocate or modify structures that interfere with the air intake or exhaust • Optimize cooling tower fan blade angle on a seasonal and/or load basis • Correct excessive and/or uneven fan blade tip clearance and poor fan balance • In old counter-flow cooling towers, replace old spray type nozzles with new square spray nozzles that do not clog • Replace splash bars with self-extinguishing PVC cellular film fill • Install nozzles that spray in a more uniform water pattern • Clean plugged cooling tower distribution nozzles regularly • Balance flow to cooling tower hot water basins • Cover hot water basins to minimize algae growth that contributes to fouling • Optimize the blow down flow rate, taking into account the cycles of concentration (COC) • limit	1 mark each for any four

		• Replace slat type drift eliminators with low-pressure drop, self-extinguishing PVC cellular units Restrict flows through large loads to design values	
	b	**Difference between conventional and non-conventional energy sources**	1 mark for each difference

criteria	Renewable energy sources	Non renewable energy sources
availability	These sources can renew again and again.	These sources are exhaustible after use.
pollution	These sources are pollution free.	These sources are creating pollution.
cost	Capital investment is more but fuel cost zero for power generation	Capital investment is less but fuel cost is more for power generation
application	Most common application is for preparation of food, drying grains	Most common application is for generation of electricity and heat

	c	**Principle of energy audit** Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame. The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. Energy Audit provides a “bench-mark" (Reference point) for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.	2
		Instruments used for energy audit: • Electrical measuring instruments- to measure current, voltage, power, PF • Combustion analyzer- For flue gas analysis • Thermometer (contact thermometer)- For temperature measurement • Infrared thermometer- For temperature measurement	2

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<tr><td></td><td></td><td>

- Flow meter – Doppler effect, ultra sonic – for flow measurement
- Leak detector- To find change in pressure
- Lux meter – to measure intensity of light

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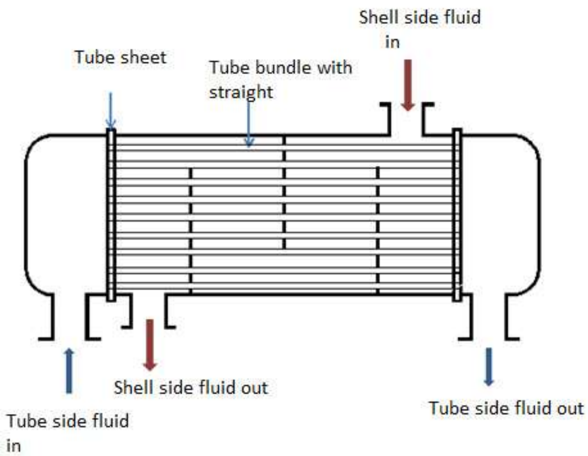
<tr><td></td><td>d</td><td>

Types of Heat exchanger by construction

- Shell and tube
- Double pipe
- Finned tube
- Plate type

1-1 Shell and tube heat exchanger



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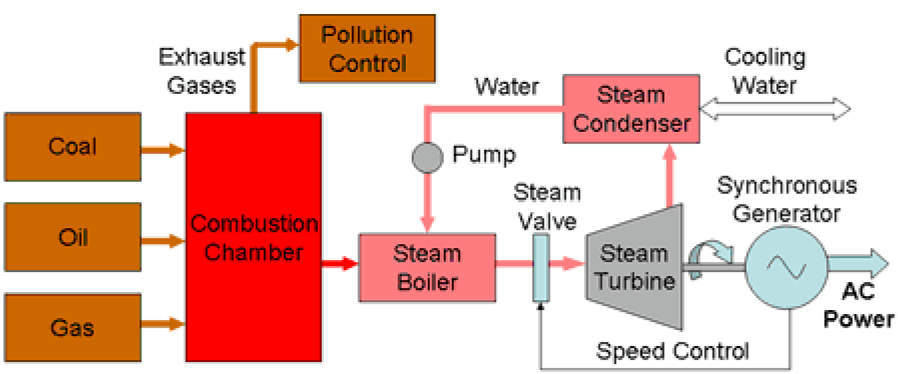
<tr><td></td><td>e</td><td>

Electricity generation form thermal power plant



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<tr><td>**3**</td><td></td><td>**Attempt any four of the following**</td><td>**16**</td></tr>
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<tr><td></td><td>a</td><td>Salient features of Energy conservation act 2001

The Act empowers the Central Government and, in some instances, State Governments to:
specify energy consumption standards for notified equipment and appliances; direct mandatory display of label on notified equipment and appliances;
prohibit manufacture, sale, purchase and import of notified equipment and appliances not conforming to energy consumption standards;
notify energy intensive industries, other establishments, and commercial buildings as designated consumers;
establish and prescribe energy consumption norms and standards for designated consumers;
prescribe energy conservation building codes for efficient use of energy and its conservation in new commercial buildings having a connected load of 500 kW or a contract demand of 600 kVA and above;
direct designated consumers to -
designate or appoint certified energy manager in charge of activities for efficient use of energy and its conservation;
get an energy audit conducted by an accredited energy auditor in the specified manner and interval of time;
furnish information with regard to energy consumed and action taken on the recommendation of the accredited energy auditor to the designed agency;
comply with energy consumption norms and standards;
prepare and implement schemes for efficient use of energy and its conservation if the prescribed energy consumption norms and standards are not fulfilled;
get energy audit of the building conducted by an accredited energy auditor in this specified manner and intervals of time.</td><td>1 mark each for any four features</td></tr>
<tr><td></td><td>b</td><td>Three T`s of combustion</td><td></td></tr>
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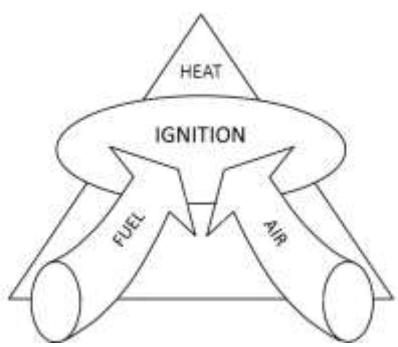
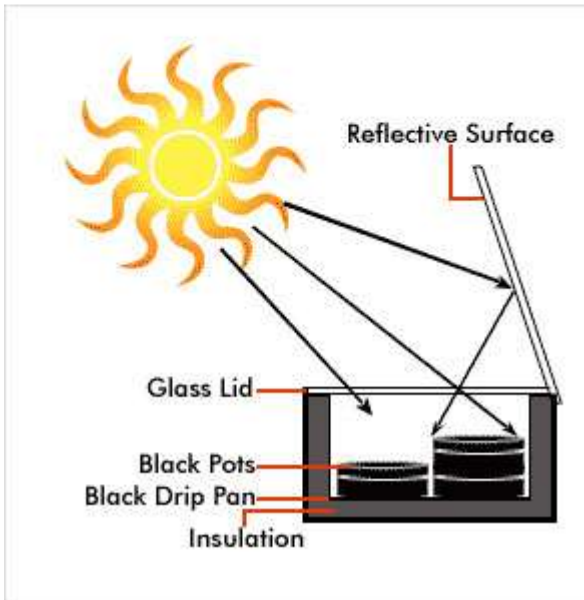
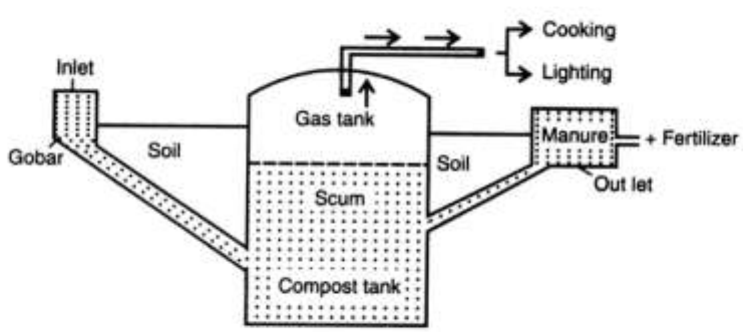
		Combustion efficiency can be explained in terms of 3 T`s Time, temperature and turbulence. Simply stated, thermal oxidation is the effective employment of the process which provide through mixing of an organic substance with sufficient oxygen at a high enough temp. for a sufficient time to cause the organic to oxidize to the desire degree of completion . To achieve successful thermal oxidation , the thermal oxidizer must include : a) Turbulence – through mixing b) Temperature- oxidizing temperature (1200 – 1650 F) c) Time- combustion chamber residence time(0.5 – 2 secs.) The level of turbulence , the reaction temperature and the amount of time is depends on the fuel characteristics. 	2 2
	c	**Types of boilers** 1. According to Relative Passage of water and hot gases: • Water Tube Boiler • Fire-tube Boiler 2. According to Water Circulation Arrangement: • Natural Circulation • Forced Circulation 3. According to the Use: • Stationary Boiler	3

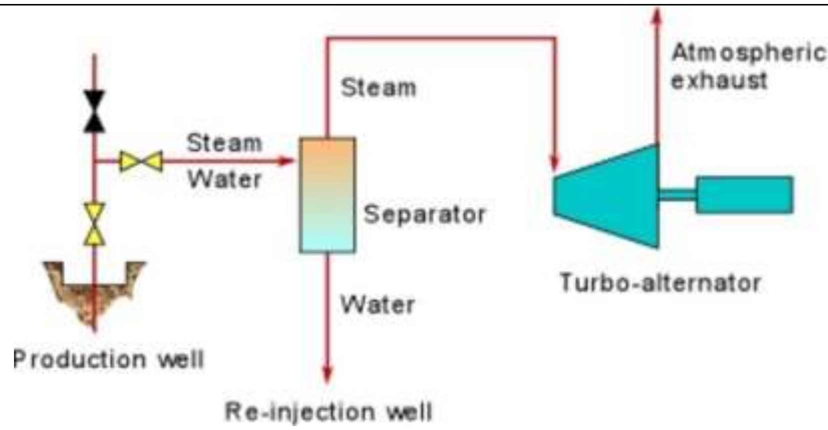
		• Portable Boiler • Locomotive • Marine Boiler **Boiler Evaporation ratio** Evaporation ratio = quantity of steam generation/quantity of fuel consumed	1
	d	**Box type solar cooker** The important parts of a hot box solar cooker include the outer box, inner cooking box or tray, the double glass lid, thermal insulator, mirror and cooking containers. **1. Outer Box :** The outer box of a solar cooker is generally made of G.I. or aluminum sheet or fibre reinforced plastic. **2. Inner Cooking Box (Tray) :** This is made from aluminum sheet. The inner cooking box is slightly smaller than the outer box. It is coated with black paint so as to easily absorb solar radiation and transfer the heat to the cooking pots. **3. Double Glass Lid:** A double glass lid covers the inner box or tray. This cover is slightly larger than the inner box. The two glass sheets are fixed in an aluminum frame with a spacing of 2 centimeters between the two glasses. This space contains air which insulates and prevents heat escaping from inside. A rubber strip is affixed on the edges of the frame to prevent any heat leakage. **4. Thermal Insulator:** The space between the outer box and inner tray including bottom of the tray is packed with insulating material such as glass wool pads to reduce heat losses from the cooker. This insulating material should be free from volatile materials. **5. Mirror:** Mirror is used in a solar cooker to increase the radiation input on the absorbing space and is fixed on the inner side of the main cover of the box. Sunlight falling on the mirror gets reflected from it and enters into the tray through the double glass lid. This radiation is in addition to the radiation entering the box directly and helps to quicken the cooking process by raising the inside temperature of the cooker. **6. Containers:** The cooking containers (with cover) are generally made of aluminum or stainless steel. These pots are also painted black on the outer surface so that they also	4

		absorb solar radiation directly.  **Working** • The incoming solar radiation falls onto the double glass lid and passes through it to strike the blackened cooking pots and the cooking tray. • The heat is absorbed by the blackened surface and gets transferred to the food inside the pots to facilitate cooking. • The mirror reflector is set in such a way to reflect the solar radiation falling on it to the cooker box. Up to four black painted vessels are placed inside the box. • The cooker takes 1½ to 2 hours to cook items such as rice, lentils and vegetables.	
	e	**Performance assessment of boiler** Performance of the boiler, like efficiency and evaporation ratio reduces with time, due to poor combustion, heat transfer fouling and poor operation and maintenance. Deterioration of fuel quality and water quality also leads to poor performance of boiler. Efficiency testing helps us to find out how far the boiler efficiency drifts away from the best efficiency. Measurements Required for Direct Method Testing	4

		Heat input Both heat input and heat output must be measured. The measurement of heat input requires knowledge of the calorific value of the fuel and its flow rate in terms of mass or volume, according to the nature of the fuel. For gaseous fuel: A gas meter of the approved type can be used and the measured volume should be corrected for temperature and pressure. A sample of gas can be collected for calorific value determination, but it is usually acceptable to use the calorific value declared by the gas suppliers. For liquid fuel: Heavy fuel oil is very viscous, and this property varies sharply with temperature. The meter, which is usually installed on the combustion appliance, should be regarded as a rough indicator only and, for test purposes, a meter calibrated for the particular oil is to be used and over a realistic range of temperature should be installed. Even better is the use of an accurately calibrated day tank. For solid fuel: The accurate measurement of the flow of coal or other solid fuel is very difficult. The measurement must be based on mass, which means that bulky apparatus must be set up on the boiler-house floor. Samples must be taken and bagged throughout the test, the bags sealed and sent to a laboratory for analysis and calorific value determination. In some more recent boiler houses, the problem has been alleviated by mounting the hoppers over the boilers on calibrated load cells, but these are yet uncommon. Heat output There are several methods, which can be used for measuring heat output. With steam boilers, an installed steam meter can be used to measure flow rate, but this must be corrected for temperature and pressure. It is now more viable with modern flow meters of the variable-orifice or vortex-shedding types.	
4	**A**	**Attempt any three of the following**	**12**
	a)	**Biogas Plant** **Construction**	

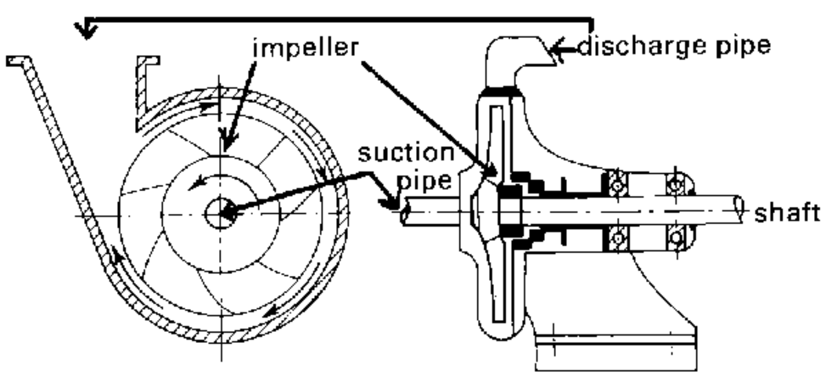
		It consits of inlet tank, digester and outlet tank. Sluury is prepeared in inlet tank. Mass is digeated in digester. Gas is collected at the top dome. Digested mass comes our from outlet tank. Gas is taken out by outlet pipe from top. **Working** • The feed material is mixed with water in the influent collecting tank The fermentation slurry flows through the inlet into the digester. • The bacteria from the fermentation slurry are intended to produce biogas in the digester. • The process of anaerobic digestion occurs in a sequence of stages involving distinct types of bacteria. • Hydrolytic and fermentative bacteria first break down the carbohydrates, proteins and fats present in biomass feedstock into fatty acids, alcohol, carbon dioxide, hydrogen, ammonia and sulfides. • This stage is called "hydrolysis" (or "liquefaction"). • Next, acetogenic (acid-forming) bacteria further digest the products of hydrolysis into acetic acid, hydrogen and carbon dioxide. • Methanogenic (methane-forming) bacteria then convert these products into biogas. • The combustion of digester gas can supply useful energy in the form of hot air, hot water or steam. 	1 1 2
	b)	**Active Power:** Active - or real or true - power is the power that is used to do work on the	1

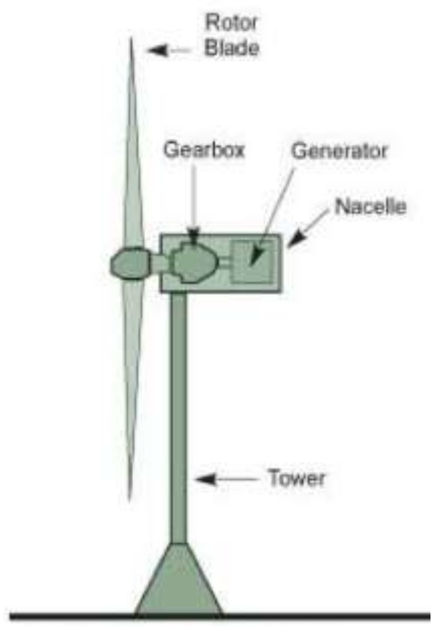
		load. Active power is measured in watts (W) and is the power drawn by the electrical resistance of a system doing useful work. **Reactive Power:** The power which flows back and froth that mean it moves in both the direction in the circuit or react upon itself, is called Reactive Power.The reactive power is measured in kilo volt ampere reactive (kVAR) or MVAR. **Apparent Power:** Apparent power is the power supplied to the circuit. Apparent Power is measured in volt-amperes (VA) and is the voltage on an AC system multiplied by all the current that flows in it. **The power factor:** of an AC electrical power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit, and is a dimensionless number between 0 and 1. Power Factor (PF) is the ratio between the active power (kW) and apparent power (kVA).	1 1 1
	c)	**Geothermal energy** Geothermal power plants use steam produced from reservoirs of hot water found a few miles or more below the Earth's surface to produce electricity. The steam rotates a turbine that activates a generator, which produces electricity. There are three types of geothermal power plants: dry steam, flash steam, and binary cycle. Water is introduced into heat source which produces steam. Steam I will act as primary heat source to produce steam again.. If primary steam is used in the turbine, it will be damaged in short time. Hence clean steam is used. Alternator connected to turbine will produce electricity.	4

			
	d)	**Types of energy audit** 1. Preliminary/walk through energy audit 2. Primary energy audit 3. Detailed energy audit **Detailed Energy Audit** Detailed energy audit includes a complete description of the facility, including an equipment inventory, an energy balance, detailed energy savings and costs associated with each low-cost and not-cost measure, financial analysis of each recommended measure, identification and rough estimates of capital project costs and savings. Energy savings and economic feasibility are determined as accurately as possible. The reports contain more detailed descriptions of the measures. The portable instruments, trend logs and data loggers are used in detailed energy audits for assessing the current performance accurately .The scope of an energy audit includes an examination of the following areas: Energy generation/conversions equipments like boilers, furnaces, Heaters ,pumps, fans, compressors, transformers etc. Energy distribution network of electricity, water, steam, condensate, compressed air etc.	1 3

		Energy utilization efficiency of all equipment and buildings. Efficient planning, operation, maintenance and housekeeping Management aspects of design and operating data collection, field measurements, data analysis, and training	
	B	**Attempt any one of the following**	**6**
	a)	**Boiler efficiency Direct method** This is also known as 'input-output method' due to the fact that it needs only the useful output (steam) and the heat input (i.e. fuel) for evaluating the efficiency. This efficiency can be evaluated using the formula: Boiler Efficiency (η) = (Heat output/Heat input)x 100 Boiler Efficiency (η) =[Qx(h_g-h_f)/q X GCV] x 100 Parameters to be monitored for the calculation of boiler efficiency by direct method are: 1. Quantity of steam generated per hour (Q) in kg/hr. 2. Quantity of fuel used per hour (q) in kg/hr. 5. Calorific value of the fuel (GCV) in kcal/kg of fuel 6. h_g – Enthalpy of saturated steam in kcal/kg of steam 7. h_f – Enthalpy of feed water in kcal/kg of water	6
	b)	**Given data:** Investment : 45,000/- Annual saving : 27000/-	4

		Annual maintenance: 12000/- Simple payback period = Total investment/ (annual saving – annual maintenance) = 45000/(27000-12000) = 3 years **Importance of pay back period:** According to this method, the project that promises a quick recovery of initial investment is considered desirable. If the payback period of a project computed by the above formula is shorter than or equal to the management's maximum desired payback period, the project is accepted otherwise it is rejected. For example, if a company wants to recoup the cost of a machine within 5 years of purchase, the maximum desired payback period of the company would be 5 years. The purchase of machine would be desirable if it promises a payback period of 5 years or less.	2
5		**Attempt any two of the following**	**16**
	a	**The Perform Achieve Trade (PAT)** is an innovative, market-based trading scheme announced by the Indian Government in 2008 under its National Mission on Enhanced Energy Efficiency (NMEEE) in National Action Plan on Climate Change (NAPCC). It aims to improve energy efficiency in industries by trading in energy efficiency certificates in energy-intensive sectors. The 2010 amendment to the Energy Conservation Act (ECA) provides a legal mandate to PAT. Participation in the scheme is mandatory for Designated Consumers under the ECA. It is being administered by the BEE that sets mandatory, specific targets for energy consumption for larger, energy-intensive facilities. The PAT Scheme was implemented in three phases- the first phase runs from 2012-2015 covering 478 facilities from eight energy-intensive sectors, namely aluminum, cement, chor-alkali, fertilizer, iron and steel, pulp and paper, textiles and thermal power plants. This accounts for roughly 60% of India's total primary energy consumption. It targets energy consumption reductions of 6.6 million tons of oil equivalent in the 478 covered facilities. The scheme imposes mandatory specific energy consumption targets on the covered facilities with less energy efficient facilities having a greater reduction target than the more energy	8

		efficient ones. A facility's baseline is determined by its historic specific energy consumption between 2007-2010. Facilities making greater reductions than their targets receive "EsCerts" or "energy saving certificates" which can be traded with facilities that are having trouble meeting their targets, or banked for future use. The PAT scheme establishes plant-specific targets rather than a sectoral target, with the average reduction target being 4.8% that is to be achieved by the end of the first phase.	
	b	**Parts of centrifugal pump** Seal: Centrifugal pump can be provided with packing rings or mechanical seal which helps prevent the leakage of the pumped liquid into the atmosphere. Shaft: The main function of the shaft in a centrifugal pump is to transmit the input power from the driver into the impeller. Casing: The casing contains the liquid and acts as a pressure containment vessel that directs the flow of liquid in and out of the centrifugal pump. Impeller: Centrifugal pumps use impeller as the primary source for their pumping action. Its function is to increase the pressure of the liquid. Bearing: The function of the bearing is to support the weight of the shaft (rotor) assembly, to carry the hydraulic loads acting on the shaft, and to keep the pump shaft aligned to the shaft of the driver. Suction and discharge nozzles**:** These are inlet and outlet for pump.  	4 4
	c	**Components of wind mill** **1) Rotor:** Blades are attached to rotor and it connected by shaft to generator.	4

		2) Blades: Wind lift and drag force will act on blades which are connected to rotor. **3) Shaft:** It is used to transmit mechanical power produced by blades to generator. **4) Generator:** It is device used to produce electricity using mechanical energy. **5) Tower:** It is assembly on which wind turbine is placed at certain height.  	4
6		**Attempt any two of the following**	**16**
	a	**Factors affecting cooling tower performance** • Wet bulb temperature of air • Dry bulb temperature of air • Cooling tower inlet water temperature • Cooling tower outlet water temperature • Exhaust air temperature • Electrical readings of pump and fan motors • Water flow rate • Air flow rate	1 mark each

	b	**Energy Management** An energy management system is a systematic process for continually improving energy performance and maximizing energy savings. The principle of an energy management is to engage and encourage staff at all levels of an organisation to manage energy use on an on-going basis. It also offer industrial facilities to manage their on-going energy use and identify opportunities to adopt energy-saving technologies, including those opportunities that do not necessarily require capital investment. An energy management helps ensure that energy efficiency improvements do not just happen on a one-time basis, but rather are continuously identified and implemented in a process of constant improvement. Experience has shown that even optimised systems lose their initial efficiency gain over time due to personnel and production changes if energy efficiency is not integrated into management practices In chemical industry distillation operation consumes more energy which can be reduced by process improvement. **Energy Efficiency** Energy efficiency is defined as the use of energy in an optimum manner to achieve the same service that could have been achieved using a common less efficient manner. Energy efficiency is the practice of reducing the energy requirements while achieving the required energy output. Replacement of old boiler with energy efficient boiler. **Energy Conservation** Energy conservation are efforts made to reduce the consumption of energy by using less of an energy service. This can be achieved either by using energy more efficiently (using less energy for a constant service) or by reducing the amount of services used (for example, by driving less). Energy conservation is a part of the concept of eco-sufficiency. Energy conservation reduces the need for energy services, and can result in increased environmental quality, national security, personal financial security and higher savings. It is at the top of the sustainable energy hierarchy. It also lowers energy costs by preventing future resource depletion. Use combined heat and power through co generation in industry.	3 2 3

	c	**Energy conservation opportunities in pumping system (any eight)** • Ensure adequate NPSH at site of installation • Ensure availability of basic instruments at pumps like pressure gauges, flow meters. • Operate pumps near best efficiency point. • Modify pumping system and pumps losses to minimize throttling. • Adapt to wide load variation with variable speed drives or sequenced control of multiple units. • Stop running multiple pumps - add an auto-start for an on-line spare or add a booster pump in the problem area. • Use booster pumps for small loads requiring higher pressures. • Increase fluid temperature differentials to reduce pumping rates in case of heat exchangers. • Repair seals and packing to minimize water loss by dripping. • Balance the system to minimize flows and reduce pump power requirements. • Avoid pumping head with a free-fall return (gravity); Use siphon effect to advantage: • Conduct water balance to minimize water consumption • Avoid cooling water re-circulation in DG sets, air compressors, refrigeration systems, cooling towers feed water pumps, condenser pumps and process pumps.	1 mark each for any eight