MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
SUMMER 2013 EXAMINATION
Model Answer

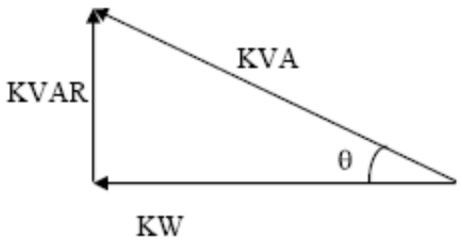
Subject & code : EMA(12205)

Important instructions to examiners :

1. The answers should be examined by keywords 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 given more importance.
4. While assessing figures, examiner may give credit for principal 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 answer and model answer.
6. In case of some questions credit may be given by judgment of relevant answer based on candidates understanding.

Q.No.	Answer	Mark	Total Mark
1.A-a	Energy can be classified into several types based on the following criteria: • Primary and Secondary energy Primary: Crude oil, coal, natural gas, wood Secondary :Naptha, gasoline , charcoal, coke oven gas • Commercial and Non commercial energy Commercial: Electricity, lignite, coal, oil, natural gas etc Non commercial: Firewood, agro waste in rural areas; solar energy for water heating, electricity generation, for drying grain, fish and fruits; animal power for transport, threshing, lifting water for irrigation, crushing sugarcane; wind energy for lifting water and electricity generation. • Renewable and Non-Renewable energy Renewable: Solar, wind, geothermal, tidal Non renewable: crude oil, coal, natural gas	1+2+1	4
1.A-b	Energy efficient lighting: Electric lighting is a major energy consumer.	2+2	4

	Enormous energy savings are possible using energy efficient equipment, effective controls, and careful design. Using less electric lighting reduces heat gain, thus saving air-conditioning energy and improving thermal comfort. Energy efficient lighting include 1) Installation of compact fluorescent lamps (CFL) in place of incandescent lamps. 2) Installation of energy-efficient fluorescent lamps in place of "conventional" fluorescent lamps. 3) use high efficiency (hid) exterior lighting 4) Use of electronic ballast in place of magnetic ballast 5) Use of LED which consumes very less power and having higher life 6) Use of separate lighting circuit. Lighting control systems are employed to maximize the energy savings from the lighting system, satisfy building codes. The term lighting controls is typically used to indicate stand-alone control of the lighting within a space. This may include occupancy sensors, time clocks, and photocells that are hard-wired to control fixed groups of lights independently. Adjustment occurs manually at each devices location. The term lighting control system refers to an intelligent networked system of devices related to lighting control. These devices may include relays, occupancy sensors, photocells, light control switches or touchscreens, and signals from other building systems (such as fire alarm of HVAC). Adjustment of the system occurs both at device locations and at central computer locations via software programs or other interface devices.		
1.A-c	Broadly energy management program initiated at micro or macro level will have the following objectives of manufactured goods (either lower process or increased) availability and profitability, and in consequence raise the standard of living both of the workers in industry and of those who buy the products. a) To reduce imports of energy and reduce the drain on foreign exchange. b) To improve exports of manufactured goods (either lower process or	1X4 (any four)	4

	increased availability helping sales) or of energy, or both. c) To reduce environmental pollution per unit of industrial output - as carbon dioxide, smoke, sulphurdioxide, dust, grit or as coal mine discard for example. d) Thus reducing the costs that pollution incurs either directly as damage, or as needing, special measures to combat it once pollutants are produced. e) Generally to relieve shortage and improve development.		
1.A-d	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). $\text{Power Factor } (\text{Cos}\Phi) = \frac{Active\ Power\ (kW)}{Apparent\ Power\ (kVA)}$ $= \frac{kW}{\sqrt{(kW)^2 + (kVAr)^2}}$ *The Power Triangle*  $P.F. = \frac{KW}{KVA} = \cos\theta$	2+2	4
1.B-a	Functions of BEE • Create awareness and disseminate information on energy efficiency and conservation • Arrange and organize training of personnel and specialists in the techniques for efficient use of energy and its conservation	1 mark each (any six)	6

	• Strengthen consultancy services in the field of energy conservation • Promote research and development • Develop testing and certification procedures and promote testing facilities • Formulate and facilitate implementation of pilot projects and demonstration projects • Promote use of energy efficient processes, equipment, devices and systems • Take steps to encourage preferential treatment for use of energy efficient equipment or appliances • Promote innovative financing of energy efficiency projects • Give financial assistance to institutions for promoting efficient use of energy and its conservation • Prepare educational curriculum on efficient use of energy and its conservation • Implement international co-operation programmes relating to efficient use of energy and its conservation		
1.B-b	Specific Heat: The specific heat is the amount of heat per unit mass required to raise the temperature by one degree Celsius. Given Data M= 20 Kg T_1= 100 °C T_2= 70 °C Cp =4.187 KJ/Kg °C Hv=200 KJ/Kg Heat given out = Latent heat + Sensible heat = M Hv + MCpX(T_2-T_1)]	1+5	6

	=M X [Hv + CpX(T_2-T_1)] = 20 X [200 + 4.187 X(100-80)] = 5674.8 KJ		
2.a	Salient Features of EC act 2001 • 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;	1X4 (Any Four)	4

	• 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; State Governments may – • Amend the energy conservation building codes prepared by the Central Government to suit regional and local climatic conditions; • Direct every owners or occupier of a new commercial building or building complex being a designated consumer to comply with the provisions of energy conservation building codes; • direct, if considered necessary for efficient use of energy and its conservation, any designated consumer to get energy audit conducted by an accredited energy auditor in such manner and at such intervals of time as may be specified		
2.b	**Components of wind turbine** **1) Rotor:** Blades are attached to rotor and it connected by shaft to generator. **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. **Working** • Tower produces turbulence behind it, the turbine is usually pointed	2+2	4

<table>
<tr>
<td></td>
<td>upwind of the tower.
• The wind passes over both surfaces of the airfoil shaped blade but passes more rapidly over the longer (upper) side of the airfoil, thus creating a lower-pressure area above the airfoil.
• The pressure differential between top and bottom surfaces results in aerodynamic lift.
• The lift force causes rotation about the hub.
• In addition to the lift force, a drag force perpendicular to the lift force impedes rotor rotation.
• When blades are rotating they give this mechanical energy to the generator shaft through gear box, which produces electricity.</td>
<td></td>
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<td>2.c</td>
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<table>
<tr><th>Gross Calorific Value</th><th>Net Calorific Value</th></tr>
<tr><td>The gross heating value is obtained when all products of the combustion are cooled down to the temperature before the combustion considering the water vapor formed during combustion is condensed.</td><td>The net or lower heating value is obtained by subtracting the latent heat of vaporization of the water vapor formed by the combustion from the gross or higher heating value.</td></tr>
<tr><td>Value is higher than NCV</td><td>Value is lower than GCV</td></tr>
<tr><td>If no hydrogen is present GCV= NCV</td><td>More hydrogen is present lower is NCV.</td></tr>
<tr><td>It is not an actual heat available for use.</td><td>It is an actual heat available for use.</td></tr>
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<td>1X4</td>
<td>4</td>
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<td>2.d</td>
<td>An energy audit is usually one of the first steps in an energy management program. It shows how efficiently energy is being used and</td>
<td>3+1</td>
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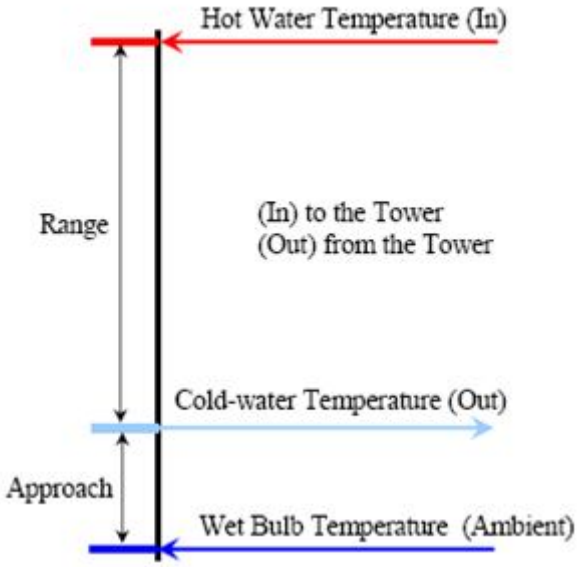
highlights opportunities for energy cost savings. It can also show ways to improve productivity. Energy audits take a thorough look at particular facilities, processes or technologies.

- In any industry, the three top operating expenses are often found to be energy (both electrical and thermal), labour and materials. If one were to relate to the manageability of the cost or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and thus energy management function constitutes a strategic area for cost reduction.
- Energy Audit will help to understand more about the ways energy and fuel are used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists.
- The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc.
- In general, 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.

	The type of Energy Audit to be performed depends on: - Function and type of industry - Depth to which final audit is needed, and - Potential and magnitude of cost reduction desired Thus Energy Audit can be classified into the following two types. 1) Preliminary energy audit 2) Detailed Audit		
2.e	The performance of cooling towers is evaluated to assess present levels of approach and range against their design values, identify areas of energy wastage and to suggest improvements. During the performance evaluation, portable monitoring instruments are used to measure the following parameters: • 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 These measured parameters and then used to determine the cooling tower performance in several ways. These are	4	4



a**) Range** . This is the difference between the cooling tower water inlet and outlet temperature. A high CT Range means that the cooling tower has been able to reduce the water temperature effectively, and is thus performing well.

The formula is:

CT Range (°C) = [CW inlet temp (°C) – CW outlet temp (°C)]

b) **Approach** . This is the difference between the cooling tower outlet cold water temperature and ambient wet bulb temperature. The lower the approach the better the cooling tower performance. Although, both range and approach should be monitored, the `Approach' is a better indicator of cooling tower performance.

CT Approach (°C) = [CW outlet temp (°C) – Wet bulb temp (°C)]

c) **Effectiveness.** This is the ratio between the range and the ideal range (in percentage), i.e. difference between cooling water inlet temperature and ambient wet bulb temperature, or in other words it is = Range / (Range + Approach). The higher this ratio, the higher the cooling tower effectiveness.

CT Effectiveness (%) = 100 x (CW temp – CW out temp) / (CW in temp –

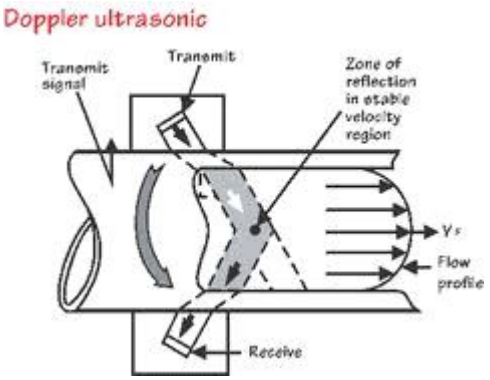
	WB temp) d) **Cooling capacity**. This is the heat rejected in kCal/hr or TR, given as product of mass flow rate of water, specific heat and temperature difference.		
2.f	• In 2005, total worldwide energy consumption was 500 EJ (= 5 x 10^{20} J) with 86.5% derived from the combustion of fossil fuels. This is equivalent to 15 TW (= 1.5 x 10^{13} W) of power. • Most of the world energy resources are from the sun's rays hitting earth - some of that energy has been preserved as fossil energy, some is directly or indirectly usable e.g. via wind, hydro or wave power. Total world energy supply is shown in table 5.1. • Crude oil supply to world is through OPEC countries. Price of crude oil is fluctuating and depend on the demand and supply. • The global proven oil reserve was estimated to be 1147 billion barrels by the end of 2003. Saudi Arabia had the largest share of the reserve with almost 23%. (One barrel of oil is approximately 160 litres) • The proven global coal reserve was estimated to be 9,84,453 million tonnes by end of 2003. The USA had the largest share of the global reserve (25.4%) followed by Russia (15.9%), China (11.6%). India was 4th in the list with 8.6%. • The global proven gas reserve was estimated to be 176 trillion cubic metres by the end of 2003. The Russian Federation had the largest share of the reserve with almost 27%. • The global primary energy consumption at the end of 2003 was equivalent to 9741 million tonnes of oil equivalent (Mtoe). Table shows in what proportions the sources mentioned above contributed to this global figure. The primary energy consumption for few of	4	4

	the developed and developing countries are shown in Table 1.1. It may be seen that India's absolute primary energy consumption is only 1/29th of the world, 1/7th of USA, 1/1.6th time of Japan but 1.1, 1.3, 1.5 times that of Canada, France and U.K respectively.		
3.a	**Maximum Demand** is the power consumed over a predetermined period of time, which is usually between 8 – 30 minutes. The most common period of time, in the majority of countries is 15 minutes. This power is calculated and billed by a kW demand meter, which records the highest kW value in one 15 minute period, over a month's time. **HOW TO CONTROL MAXIMUM DEMAND?** The purpose of controlling the demand is not to exceed the contracted maximum demand limit. One way to do this is to shed non-critical loads. It is possible by using maximum demand controller. It will switch off non critical load by using logical sequence program. Possible loads to be disconnected: • Lights • Compressors • Air conditioners • Pumps • Fans and extractors • Packaging machinery • Shredders • Others Generally, all those machine which do not affect the main production process or which are not essential. In addition to controlling kW demand, the following equipment is suitable for processes which have large variations in kW demand and low loading factors, such as companies in the smelting, mining, automobile, textile, paper industries, etc.	1 3	4

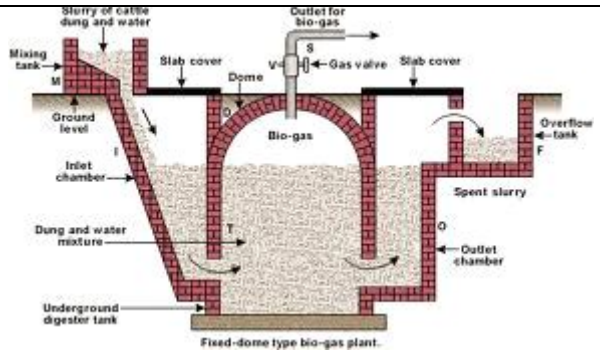
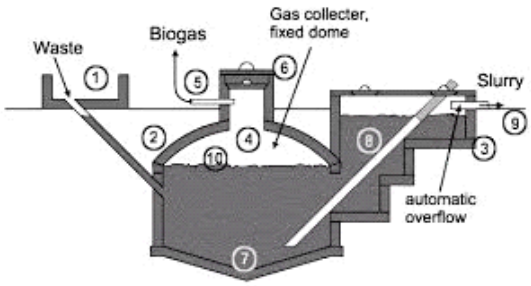
3.b	The modes of heat transfer are conduction, convection, radiations. **Their Basic differences-** Conduction is heat transfer between part of the same material or different material which is adjacent to one another. It is heat transfer without movement of particles. Convection is heat transfer from one material to another via a medium, such as air or water. It is heat transfer with the movement of particles. Radiation is heat transfer without any medium and through electromagnetic waves, such as between the Sun and the Earth.	2 2	4
3.c	**The need of energy audit-** In any industry, the three top operating expenses are often found to be energy (both electrical and thermal), labour and materials. If one were to relate to the manageability of the cost or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and thus energy management function constitutes a strategic area for cost reduction. Energy Audit will help to understand more about the ways energy and fuel are used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists. The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc. In general, 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	4	4

	managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.		
3.d	**Benchmarking and energy performance-** Benchmarking of energy consumption internally (historical / trends analysis) and externally (across similar industries) are two powerful tools for performance assessment and logical evolution of avenues for improvement. Historical data well documented helps to bring out energy consumption and cost trends month-wise / day-wise. Trend analysis of energy consumption, cost, relevant production features, specific energy consumption, help to understand effects of capacity utilization on energy use efficiency and costs on broader scale. External benchmarking relates to inter-unit comparison across a group of similar unit. However, it would be important to ascertain similarities, as otherwise findings can be grossly misleading. Few comparative factors, which need to be looked into while benchmarking externally are- Scale of operation, vintage of technology, raw material specifications and quality, product specifications and quality. **Benchmarking energy performance permits-** 1. Quantification of fixed and variable energy consumption trends vis-à-vis production levels. 2. Comparison of the industry energy performance with respect to various production levels (capacity utilization). 3. Identification of best practices (based on the external benchmarking data). 4. Scope and margin available for energy consumption and cost reduction. 5. Basis for monitoring and target setting exercises. (Give some benchmarking examples.)	4	4
3.e	**Photovoltaic cell** means solar cell. It is a device that converts light into direct current using the photoelectric effect. **Its applications-**	1 3	4

	1. The earliest significant application of Photovoltaic cells was as a back-up power source to the Vanguard I satellite, which allowed the satellite to continue transmitting for over a year after its chemical battery was exhausted. 2. It went on to play an essential part in the success of early commercial satellites such as Telstar and continue to remain vital to the telecommunications infrastructure today. 3. Early terrestrial uses included powering telecommunication stations, off-shore oil rigs, navigational buoys and railroad crossings.		
4.a.a	**Energy monitoring & targeting** -The physical energy survey -outgoing monitoring and analysis of energy consumption information Energy survey is an investigation of the control and flow of energy. the aim of the survey is to gain understanding and identify cost-effective energy saving measures. Survey include an examination of energy conversion, distribution and end-use, together with management system, survey categories of no-cost, low- cost, medium- cost, high-cost measures. The second activity should consist of an examination of energy bills before they are paid and a comparison with expectations. This two activities referred as M & T. **Four elements of M & T** --data collection from no. of possible sources including energy bills, manual meter reading, automatic meter reading, half-hourly data from utilities, plus in-house production information & meterological data, validation of utility bills --analysis & interpretation to turn the data into useful information --reporting of appropriate information --action responding to unexpected excess consumption	2 2	4
4.a.b	Natural gas comprises several gases, but mainly methane(greater than 85 %),its clean fuel ,its high pressured (220 atm.)stored in specially designed	2+1+1	4

	container, the design & inspection are must to withstand high pressure and +to avoid damage and accidents, cost of installation and inspection in smaller road vehicles is economic, used in transport vehicles, transport of CNG by ship, the calorific value of NG expressed in MJ per cubic meter, the calorific value of pure methane at 25 deg. C is55.52 GJ/tone State uses of CNG. State Environmental advantages		
4.a.c	**Calculation of flow rate** -Ultrasonic flow meter -tracer method -tank filling method i) Two **ultrasonic transducers** are employed in the system. one transmit the a continuous ultrasonic waves into the flow, another one is used to receive the ultrasonic waves back scattered from suspending particles (or targets). The received waves has a frequency shift comparing with the transmitted one. This shift is the so-called Doppler frequency shift. Proportional to the flow velocity. Therefore, by detecting the Doppler frequency, we are able to derive the flow velocity. The flow rate of pipe flow is then obtained by computing the product of the velocity and the cross-sectional area of the pipe.  ii) **Tracer method**-- the tracer method particularly suitable for cooling	2 2 marks for any one method	4

	water flow measurement because of their sensitivity & accuracy. This method is based on injecting a tracer into the cooling water for a few minutes at an accurately measured constant rate. A series of samples is extracted from the system at a pt. where the tracer has become completely mixed with the cooling water. The mass flow rate is calculated from: $Qcw= Q_1 \times C_1/C_2$ Qcw = cooling water mass flow rate. Kg/s Q_1 = mass flow rate of injected tracer. Kg/s C_1= conc. Of injected tracer, Kg/Kg C_2 = conc. Of tracer at downstream position during the 'plateau' period of constant conc. Kg/Kg Tracer normally used is sodium chloride. iii**) tank filling method**—in open-flow systems such as water getting pumped to an overhead tank or a sump, the flow can be measured by noting the difference in tank level for a specified period during which the outlet flow from the tank is stopped. The internal tank dimensions should be preferable taken from the design drawing in the absence of which direct measurements may be resorted to.		
4.a.d	i) **floating drum type**-biogas plant consist of a deep well-shaped underground digester connected by inlet and outlet pipes. a mild steel gas storage drum,inverted over the slurry, rises and falls around a guide pipe corresponding to the accumulation and withdrawal of gas.	4 marks for any one	4

	 ii) **fixed-dome type-** biogas plant consist of one door segment and hemisphere over it (for both digester & gas holder). the mixing tank is connected to the digester by a 15 cm asbestos cement pipe. through the outlet for provided in the digester , the slurry is push into the outlet tank & overflows through another hole provided in the outlet tank. 		
4.b. a	**Instruments used for energy audit—** i)electrical measuring instruments-used for measure electrical parameters such as KVA, KW,PF, AMPS & Hurts  ii) Combustion analyser-it measures various gases such as oxygen, CO,NOx, SOx etc.. iii) thermometer (contact thermometer)-- these are thermocouples which	Figures are not necessary 1mark for any six	6

	measure for e.g. flue gas, hot air, hot water temp. by inserting of probe into the stream iv) infrared thermometer--this is non-contact type measurement which when directed at a heat source directly gives the temp. read out.  v)flowmeters-- used for water flow measurement & other fluids e.g. doppler effect, ultra sonic principle  vi) leak detector-ultrasonic instruments are available which can be used to detect leaks of compressed air, other gases which are normally not possible with human ability		

	 vii) lux meter- illumination levels are measured with a lux meter, it consist of a photo cell which senses the light output converts to electrical impulses which are calibrated as lux 		
4.b. b	**energy conservation opportunities in pumping system-** 1. ensure adequate NPSH at site of installation ensure availability of basic instruments at pumps like pressure gauge, flow meter., 2. operate pump near best efficiency pt., modify pump system & pumps losses to minimize throttling, adopt wide load variation with variable speed drives or sequenced control of multiple units, 3. stop running multiple pumps add an auto star for an on-line spare or add a booster pump in a the problem area, use booster pump for	1 mark for any six	6

	small loads requiring higher pressure, 4. increase fluid temp. differentials to reduce pumping rates in case of H.E., repairs seals and packing to minimize water loss by dripping, 5. balance the system to minimize flows and reduce pump power requirements, 6. avoid pumping head with free fall return use siphon effect to advantage, 7. conduct water balance to minimize water consumption.		
5.a	**NPSH** The value which the pressure in the pump suction exceeds the liquid vapour pressure, is expressed as a head of liquid and referred to as Net positive Suction Head. This is characteristics of the system design. **Pump Performance** The work performed by a pump is a function of the total head and of the weight of the liquid pumped in a given time period. Pump horsepower delivered to the pump shaft ,and can be calculated as follows: Pump shaft power P_s= Hydraulic power hp/Pump efficiency η_{pump}	2 2	4
5.b	**Maximum demand:** Maximum demand is the power consumed over a predetermined period of time, which is usually between 8-30 minutes. The most common period of time, in the majority of countries, is 15 mins. This power is calculated and billed by a kW demand meter, which records the highest kW value in one month's time. **Contract demand**: Contract demand is the amount of electric power that a customer demands from utility in a specified interval. Unit used is KVA or kW. It is the amount of electric power that the consumer agreed upon with the utility.	2 2	4
5.c	**Properties of liquid fuel**:	4	4

	i) Viscosity ii) Specific gravity iii) Calorific value iv) Flash point and fire point v) Ash content vi) Water content (Elaborate above terms)		
5.d	**Preliminary Energy Audit**: • Identifies the quantity and cost of energy forms and in the plant. • Energy Consumption in various equipment /Sections, Process Level. • Relates energy input to production and Highlights the Wastage of Energy in Equipment /process areas. • Recommendations for low cost energy conservation measures. • Identification of major areas/equipment require in depth study/analysis. **Detailed Energy Audit**: It involves • Detailed Mass and Energy Balance of Major Energy Consuming Equipment. • Evaluation of system efficiencies. • Identification of various measures for improving the End Use of Energy Efficiently. • Proposals for major retrofitting /Replacement/Modifications providing cost-benefit analysis.	2 2	4
5.e	**Energy security** The basic aim of energy security for a nation is to reduce its dependency on the imported energy sources for its economic growth. India will continue to experience an energy supply shortfall throughout	4	4

	the forecast period. Increasing dependence on oil imports means reliance on imports from the Middle East, a region susceptible to disturbances and consequent disruptions of oil supplies. Some of the strategies that can be used to meet future challenges to their energy security are • Building stockpiles • Diversification of energy supply sources • Increased capacity of fuel switching • Demand restraint • Development of renewable energy sources • Energy efficiency • Sustainable development		
5.f	**Tidal energy** The technology required to convert tidal energy into electricity is comparable to technology used in traditional hydraulic power plants. The first requirement is a dam across a tidal bay or estuary. Gates and turbines are installed .The rise and fall of tides have become the basis to produce electrical power similar to the principles of hydraulic power generation. **Ocean energy** It is the energy which is generated by using the temperature difference that exists between deep and shallow waters to run a heat engine. Earth's oceans are continually heated by the sun .This is the original source of temperature differences between surface of the ocean and deep of the ocean.	2 2	4

6.a	**3Ts of combustion are**: Turbulence – Thorough mixing Temperature – oxidizing temperature (typically $1200^0F – 1650^0F$) Time – Combustion chamber residence time (typically 0.5 seconds – 2.0 seconds) the "three Ts of combustion" along with sufficient oxygen are essential and interrelated in all thermal oxidizer designs. The level of turbulence, the necessary reaction temperature, and the amount of time is primarily dependent on the fuel characteristics.	4	4
6.b	$Q=UALMTD \times f_t$ $Q=116\ kw = 116 \times 1000\ w$ $LMTD= 23k$ $A=1.5\ m^2$ $f_t= 0.85$ hence $U= Q/A.LMTD.f_t= 116 \times 1000/1.5 \times 23 \times 0.85$ $=3955.669\ w/m^2k$	1 1 2	4
6.c	a) **Energy conservation measures** : 1. Improved fuel storage, handling and preparation practices. 2. Insulation of steam lines and equipment. 3. Power factor improvement 4. Optimization 5. fuel substitution, modernization of equipment and process	4	4
6.d	I. Electrical to thermal e.g. toaster, hair dryer, heater etc II. Electrical to mechanical e.g. fan, blower etc III. Solar to electrical e.g. solar cell	1 mark each	4

	IV. Chemical potential to electrical e.g. battery		
6.e	a) **Effectiveness of cooling tower** : This is the ratio between the range to (range +approach) CT effectiveness (%)= 100 x (CW temp – CW out temp)/(CW in temp – WB temp) **Liquid/gas ratio of CT**: The L/G ratio of a cooling tower is the ratio between the water and the air mass flow rates. L/G= $(h_2-h_1)/(T_1-T_2)$	2 2	4