15th NATIONAL CERTIFICATION EXAMINATION FOR ENERGY MANAGERS & ENERGY AUDITORS – August, 2014

PAPER – 1: General Aspects of Energy Management & Energy Audit

Date: 23.08.2014 Timings: 09:30-12:30 HRS Duration: 3 HRS Max. Marks: 150

Section - I: OBJECTIVE TYPE **Marks: 50 x 1 = 50**

a) Answer all **50** questions
b) Each question carries **one** mark
c) Please hatch the appropriate oval in the OMR answer sheet with Black Pen or HB pencil

1.	A geothermal field may yield a) dry steam b) wet steam c) hot air d) all of these
2.	Which of the following is not a greenhouse gas ? a) CFCs b) SO_2 c) PFC d) SF_6
3.	Bio-gas generated through anaerobic process mainly consists of a) only methane b) methane and carbon dioxide c) only ethane d) none of these
4.	Which of the following statements are true? i) bagasse is a source of secondary energy ii) beneficiated coal belongs to primary energy iii) electricity is basically a convenient form of primary energy iv) steam is a convenient form of secondary energy a) (ii) & (iii) b) (i) & (iii) c) (ii) & (iv) d) (ii) & (i)
5.	Natural gas contains a) methane, ethane and propane in equal proportions b) only butane and propane in equal proportions c) methane, propane and pentane in equal proportions d) mostly methane and minor amounts of other gases
6.	Which issue is not addressed by Integrated Energy Policy? a) consistency in pricing of energy b) scope for improving supply of energy from varied sources c) energy conservation Research and Development

	d) <u>reducing price of energy</u>
7.	Which of the following statement is not true regarding energy security? a) <u>impaired energy security will not affect agricultural output</u> b) energy security is strengthened by avoiding dependence upon imported energy c) diversifying energy supply from different countries strengthen energy security d) strengthening energy security requires increasing exploration to find oil and gas reserves
8.	In a boiler substitution of coal with rice husk leads to a) energy conservation b) energy efficiency c) both energy conservation and energy efficiency d) <u>carbon emission reduction</u>
9.	A building intended to be used for commercial purpose will be required to follow Energy conservation building code under Energy Conservation Act, 2001 provided its a) connected load is 120 kW and above b) contract demand is 100 kVA and above c) <u>connected load is100 kW and above or contract demand is 120 kVA and above</u> d) connected load is 500 kW and contract demand is 600 kVA
10.	Which of the following is not a part of energy audit as per the Energy Conservation Act, 2001? a) monitoring and analysis of energy use b) verification of energy use c) submission of technical report with recommendations d) <u>ensuring implementation of recommended measures followed by review</u>
11.	Which of the following criteria is a responsibility of Designated Consumers? a) designate or appoint an accredited Energy Auditor b) <u>adhere to stipulated energy consumption norms and standards as notified</u> c) submit the status of energy consumption information every three years d) conduct energy audit through a certified energy auditor periodically
12.	Which of the following is an energy security measure? a) fully exploiting domestic energy resources b) diversifying energy supply source c) substitution of imported fuels for domestic fuels to the extent possible d) <u>all of the above</u>
13.	An induction motor with 11 kW rating and efficiency of 90% in its name plate means a) <u>it will draw 12.22 kW at full load</u> b) it will always draw 11 kW at full load

	c) it will draw 9.9 kW at full load d) nothing can be said about how much power it will draw as motor power factor is not given
14.	Which of the following statement is true regarding maximum demand controller? a) maximum demand controller enables a way of 'shaving' the peaks in the consumer load profile b) maximum demand controller enables a way of improving the system power factor c) enables a way for using more electrical energy at lower total cost of energy without investment in expansion of power supply d) maximum demand controller is installed by concerned utility at customer premises
15.	Which of the following statements are true? i) reactive current is necessary to build up the flux for the magnetic field of inductive devices ii) some portion of reactive current is converted into work iii) the cosine of angle between kVA and kVAr vector is called power factor iv) the cosine of angle between kW and kVA vector is called power factor a) i & iv b) ii & iii c) i & iii d) iii & iv
16.	Which of the following is a standard for Energy Management System? a) ISO 14001 b) ISO 9001 c) ISO 18001 d) ISO 50001
17.	Which of the following statements are true regarding simple payback period? a) considers impact of cash flow even after payback period b) takes into account the time value of money c) considers cash flow throughout the project life cycle d) determines how quickly invested money is recovered
18.	Which of the following statements are true regarding CPM? i) work breakdown structure are used to list the activities in the project as a first step in CPM ii) CPM takes into account variation in the completion time and average time is used for any activity iii) if the project is to finish earlier, it is necessary to focus on activities other than critical path iv) critical path is the longest path in the network. a) i & iv b) i & iii c) ii & iv d) iii & iv
19.	Which of the following statements is not correct? Global warming will result in:

	a) melting of the ice caps b) increasing sea levels c) <u>severe damage to ozone layer in stratosphere</u> d) unpredictable climate patterns
20.	The process of capturing CO_2 from point sources and storing them is called a) <u>carbon sequestration</u> b) carbon sink c) carbon Capture d) carbon absorption
21.	Which of the following statements are true regarding wind turbine? i) wind power varies as cube of rotor size ii) wind power varies as cube of wind velocity iii) wind speed has more influence on wind power than turbine area iv) practical maximum amount of energy in the wind that can be collected by wind turbine rotor is about 79% a) i & ii b) <u>ii & iii</u> c) iii & iv d) ii & iv
22.	Which of the following statements regarding evacuated tube collectors (ETC) are true? i) ETC is used for high temperatures upto 150^oC ii) because of use of vacuum between two concentric glass tube, higher amount of heat is retained in ETC iii) heat loss due to conduction back to atmosphere from ETC is high iv) performance of evacuated tube is highly dependent upon the ambient temperature a) i & iii b) ii & iii c) i & iv d) <u>i & ii</u>
23.	What percentage of the sun's energy can silicon solar panels convert into electricity? a) 30% b) <u>15%</u> c) 75% d) 50%
24.	How much theoretical power you would expect to generate from a river-based mini hydropower with flow of 20 litres/second and head of 12 metres a) <u>2.35kW</u> b) 2.44MW c) 1.67kW d) none of the above
25.	Which among the following has the highest flue gas loss on combustion due to Hydrogen in the fuel ? a) <u>natural gas</u> b) furnace oil c) coal d) light diesel oil
26.	Energy in one Tonne of Oil Equivalent (toe) corresponds to a) 4.187 GJ b) 1.162 MWh c) 1 Million kcal d) <u>none of the above</u>
27.	Tonnes of Oil Equivalent energy consumption / GDP in Million US $ is termed as a) <u>energy intensity</u> b) per capita oil consumption c) per capita energy consumption d) energy performance

28.	Assume CO_2 equivalent emissions by the use of a 60 W incandescent lamp are of the order of 60 g/hr. If it is replaced by a 5 W LED lamp then the equivalent CO_2 emissions will be a) nil b) 5 g/hr c) 12 g/hr d) 300 g/hr
29.	Under the Energy Conservation Act, the designated consumer is required to get the mandatory energy audit conducted by a) certified energy manager b) certified energy auditor c) accredited energy auditor d) in-house engineer
30.	If the relative humidity of air is 100%, then which of the following statements is correct a) only dew point & wet bulb temp. are same b) only dew point & dry bulb temp. are same c) only wet bulb & dry bulb temp. are same d) all dew point , wet bulb & dry bulb temp. are same
31.	Among which of the following fuel is the difference between the GCV and NCV maximum? a) coal b) furnace oil c) natural gas d) rice husk
32.	Non-contact speed measurements can be carried out by a) tachometer b) stroboscope c) oscilloscope d) speedometer
33.	Which of the following instrument is used for assessing combustion efficiency ? a) lux Meter b) pitot tube & manometer c) ultrasonic flow meter d) fyrite
34.	The benchmarking parameter for a vapour compression refrigeration system is a) kW / kg of refrigerant used b) kcal / m^3 of chilled water c) BTU / Ton of Refrigeration d) kW / Ton of Refrigeration
35.	If 800 kcal of heat is supplied to 20 kg of ice at 0^o C, how many kg of ice will melt into water at 0^oC. (Latent heat of fusion of ice is 80 kcal/kg) a) 1 kg b) 4 kg c) 10 kg d) 20 kg
36.	If feed of 100 tonnes per hour at 5% concentration is fed to a crystallizer, the product obtained at 25% concentration is equal to ____ tonnes per hour. a) 15 b) 20 c) 35 d) 40

37.	The return on investment (ROI), is expressed as a) annual cost / capital cost b) (first cost / first year benefits) x 100 c) NPV / IRR d) (annual net cash flow x 100) / capital cost
38.	The rate of energy transfer from a higher temperature to a lower temperature is measured in a) kCal b) Watt c) Watts per second d) none of the above.
39.	Cost of a new heat exchanger is Rs. 1.5 lakh. The simple payback period (SPP) in years considering annual savings of Rs 60,000 and annual maintenance cost of Rs 10,000 is a) 0.4 b) 2.5 c) 3 d) 6
40.	Energy sources which are inexhaustible are known as a) commercial energy b) primary energy c) renewable energy d) secondary energy
41.	1 kg of wood contains 15% moisture and 5% hydrogen by weight. How much water is evaporated during complete combustion of 1kg of wood? a) 0.6 kg b) 200 g c) 0.15 kg d) none of the above
42.	In an industry the average electricity consumption is 5.8 lakh kwh for a given period. The average production is 50000 tons with a specific electricity of 11 kwh/ton for the same period. The fixed electricity consumption for the plant is a) 58000 kWh b) 30000kWh c) 80000kWh d) none of the above
43.	The cost of replacement of inefficient compressor with an energy efficient compressor in a plant costs Rs. 8 lakhs. The net annual cash flow is Rs. 2 lakhs. The return on investment a) 18% b) 20% c) 15% d) none of the above
44.	The amount of electricity required to heat 100 litres of water from 30^{o}C to 70 ^{o}C through resistance heating is a) 0.465 kWh b) 4.65 kWh c) 465 kWh d) 2 kWh
45.	In project financing, sensitivity analysis is applied because a) almost all the cash flows involve uncertainly b) it evaluates how sensitive the project is to change in the input parameters c) it assesses the impact of 'what if one or more factors are different from what is predicted' d) it is applicable to all the above situations
46.	A process requires 120 kg of fuel with a calorific value of 4800 kcal/kg for heating with a system efficiency of 82 %. The loss would be a) 576000 kcal b) 472320 kcal c) 103680 kcal d) 480000 kcal

47.	The internal rate of return is the discount rate for which the NPV is a) positive b) zero c) negative d) less than 1
48.	Having energy policy a) satisfies regulations b) shows top management commitment c) indicates energy audit skills d) adds to the list of number other policies
49.	The producer gas is basically a) CO, H_2 and CH_4 b) only CH_4 c) only CO and CH_4 d) only CO and H_2
50.	The time between its earliest and latest start time, or between its earliest and latest finish time of an activity is a) delay time b) slack time c) critical path d) start time

……. End of Section – I …….

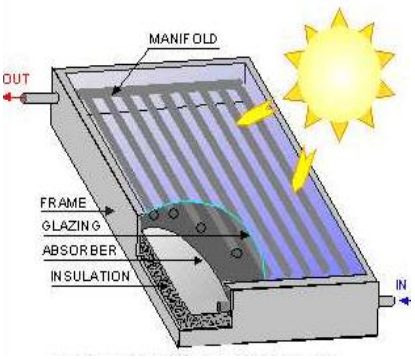
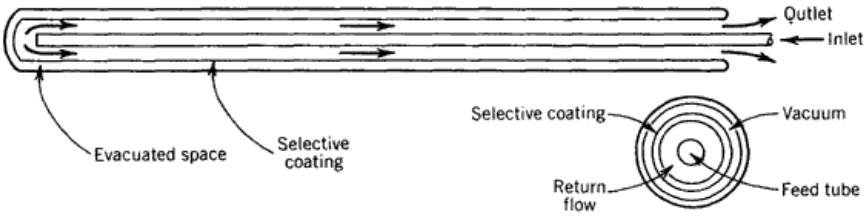
Section – II: SHORT DESCRIPTIVE QUESTIONS **Marks: 8 x 5 = 40**

(i) Answer all **Eight** questions
(ii) Each question carries **Five** marks

S-1	Calculate Net Present Value over a period of 3 years for a project with an investment of Rs 70,000 at the beginning of the first year and second investment of Rs 70,000 at the beginning of the second year and fuel cost saving of Rs 95,000 in second and third year. The discount rate is 14%
Ans	NPV = –70,000 – (70000/1.14) + [95000/(1.14x1.14)] + [95000/(1.14x1.14x1.14)] = –70000 – 61404 +73099 + 64122 = –131404 +137221 = Rs 5817/-
S-2	A water pumping station fills a reservoir at a fixed rate. The head and flow rate are constant and hence the power drawn by the pump is always same. The pump operates at 100 m head and delivers 250 litres per second. The power consumption was measured as 300 kW. Calculate energy consumption to pump 13,500 kL of water to the reservoir.
Ans	Time taken to pump water in hours = $\frac{13{,}500 \times 10^3 \text{ L}}{250 \text{ L/s} \times 3600 \text{ sec/hr}}$ = 15 hours Power required to pump water = 300 kW

	Energy consumption = 300 x 15 =4500 kWh
S-3	A conveyor delivers coal with a width of 1 m and coal bed height of 0.25 m at a speed of 0.5 m/s. Determine coal delivery in tons per hour considering coal density of 1.1 ton/m^3.
Ans	Volume of coal delivered per hour = area x length travelled per second =1 m x 0.25 m x 0.5 m/s = 0.125 m^3/s = 450 m^3/hr Coal delivery rate = 450 m^3/hr x 1.1 t/m^3 = 495 t/hr
S-4	In a process industry, 12,000 kg/hr water is currently being heated from 18^{o}Cto 80^{o}C by indirect heating of steam. An opportunity has been identified which would preheat the inlet water to 45^{o}C to reduce the steam required. Estimate the reduction in steam in kg/hr considering latent heat of steam as 520 kcal/kg in both the cases.
Ans	**Without heat recovery** Heating required (Q_1) = $mC_p\Delta T$ = 12,000 x 1 x (80-18) = 744,000 kcal/hr Steam required = 744,000 / 520 = 1431 kg/hr **After heat recovery** Heating required (Q_2) = 12,000 x 1 x (80 – 45) = 420,000 kcal/hr Steam required = 420,000/520 = 808 kg/hr Reduction in steam required = 1431 - 808 = 623 kg/hr
S-5	Write short notes on **any two** of the following: a) Building envelope b) Standards and Labeling c) Demand Side Management (DSM)
Ans	(a) Building envelope includes all components of building exposed to outside environment such as outside doors, windows, roofs etc. Its main purpose is to protect employees from outside environment.

	(b) **Standards and Labeling** (Page -35): There is a wide variation in energy consumption of similar products by various manufacturers. Also information on energy consumption is often not easily available. Standards and Labeling (S&L) has been identified as a key activity for energy efficiency improvement. The S&L program, when in place, would ensure that only energy efficient equipment and appliances would be made available to the consumers. Standards: Energy-efficiency standards are procedures and regulations prescribing the energy performance of energy-consuming products. The sale of products that are less energy efficient than minimum standards, often called Minimum Energy Performance Standards (MEPS) may be prohibited. For establishing the standards, agreed testing protocols (test procedures) are defined and value of energy performance is determined. Labels: Energy-efficiency labels are informative labels affixed to manufactured products to describe the product's energy performance (usually in the form of energy use, efficiency). These labels give consumers the data necessary to make informed purchases. Star rating is a system initiated by BEE to determine energy efficiency of an appliance. Label indicates the energy efficiency levels through the number of stars highlighted in colour on the label. It is being applied to many products such as refrigerators, TVs, ACs and so on. (c) Demand Side Management (Page -36) : Demand Side Management (DSM) means managing of the demand for power, by utilities / Distribution companies, among some or all its customers to meet current or future needs. DSM programs result in energy and / or demand reduction. For example, under this process, the demand can be shifted from peak to off peak hours thereby reducing the need for buying expensive imported power during peak hours. DSM also enables end-users to better manage their load curve and thus improves the profitability. Potential energy saving through DSM is treated same as new additions on the supply side in MWs. DSM can reduce the capital needs for power capacity expansion.
S6	a) Briefly explain why combustion of biomass fuels is considered as carbon neutral? b) Name five energy intensive industries having annual energy consumption of 30,000 metric tonne of oil equivalent and above, notified as designated consumers under the EC Act 2001

Ans	a) The CO_2 emitted by combustion of biomass fuels is largely balanced by the absorption/capture of carbon dioxide during its growth. b) 1. Thermal Power Stations 2. Fertilizer 3. Cement 4. Iron & Steel 5. Pulp & Paper
S7	Briefly explain the difference between flat plate collector and evacuated tube collector.
Ans.	(Page 260-261) Flat plate collector: ❖ The most common collector is called a flat-plate collector. ❖ Heat the circulating fluid to a temperature of about 40-60°C. ❖ Usually comprises of copper tubes welded to copper sheets (both coated with a highly absorbing black coatings) with toughened glass sheet on top for cover and insulating material at the bottom. The entire assembly is placed in a flat box.  **Solar Flat Plate Collector** Evacuated tube collector: ❖ Used For higher temperatures. ❖ Evacuated tube collector is less dependent upon ambient temperature unlike flat plate collector and its efficiency does not drop with ambient temperature. ❖ Evacuated glass tubes are used instead of copper in which case a separate cover sheet and insulating box are not required. ❖ Can reach high temperatures upto 150°C  **Evacuated Tube Collector** 

S8	A sample of coal being used in a boiler is found to contain 60% carbon and 23% ash. The refuse obtained after combustion is analysed and found to contain 7% carbon & the rest is ash. Compute the percentage of the original carbon in coal which remains as unburnt in the refuse.
Ans	Let the quantity of Refuse sample =100 kg Amount of unburnt Carbon in Refuse = 7 kg Amount of Ash in the Refuse = 93 kg Total ash in the coal that has come into the Refuse = 23% of coal 93 kg of Ash corresponds to 23% ash in the coal Therefore, quantity of total raw coal = 93 / 0.23 = 404.35 kg Quantity of original Carbon in the coal = 0.60 x 404.35 = 242.61 kg Quantity of unburnt coal in Refuse = 7 kg %age of the original carbon unburnt in the refuse = (7 / 242.61) x 100 = 2.89%

------- End of Section - II ---------

Section – III: LONG DESCRIPTIVE QUESTIONS **Marks: 6 x 10 = 60**

(i) Answer all **Six** questions
(ii) Each question carries **Ten** marks

L1	In pre-treatment process of a plating section of an engineering industry, LPG was being used indirectly to heat 6000 litres/hr of water by 10^0C. The industry is planning to convert from LPG to electrical heating. **Other data:** Annual operating hours = 3000 hours Efficiency of indirect heating with LPG = 85% Calorific value of LPG = 11000 kcal/kg, Landed cost of LPG = Rs.75/kg Cost of electricity = Rs.6/kwh. a) If LPG is replaced with electrical heating with an investment is Rs.1.5 lakhs, compute simple payback period. b) Calculate the CO_2 emissions in both the cases. Consider emission factors for LPG as 3 tons of CO_2/Ton of LPG and Electricity as 0.81 tons of CO_2/MWh

Ans

Water flow rate	6000 Litres/hr
Temperature rise	10^oC
Heat provided with LPG	(6000 x 10)=60000 kCal/hr
LPG consumption	60000/(11000 x 0.85) =6.4 kg/hr
Annual LPG consumption	6.4 x 3000 = 19.2 Tons/yr
Annual CO_2 emission with LPG heating	19.2 x 3 =57.6 t CO_2
Cost of heating with LPG	19.2 x 1000 x 75 = Rs.14.4 lakhs/annum
Electricity equivalent of LPG	(60000/860) = 70 kW 70 x 3000 = 210 MWh
Average cost of electricity	Rs. 6/kWh
Cost of electrical heating	(70 x 6) = Rs. 420/hr 420 x 3000 = Rs.12.6 lakhs
Annual CO_2 emission with electrical heating	210 x 0.81 =170 t CO_2
Annual cost savings	(14.4-12.6)
Potential annual savings	Rs.1.8 lakhs
Investment for electrical heating	Rs.1.5 lakhs
Payback period	1.5/1.8 0.83 years (< 10 months)

L2

A project has the following activities, precedence relationships, and time estimates in weeks:

Activity	Immediate Predecessors	Optimistic Time	Most Likely Time	Pessimistic Time
A	-	15	20	25
B	-	8	10	12
C	A	25	30	40
D	B	15	15	15
E	B	22	25	27
F	E	15	20	22
G	D	20	20	22

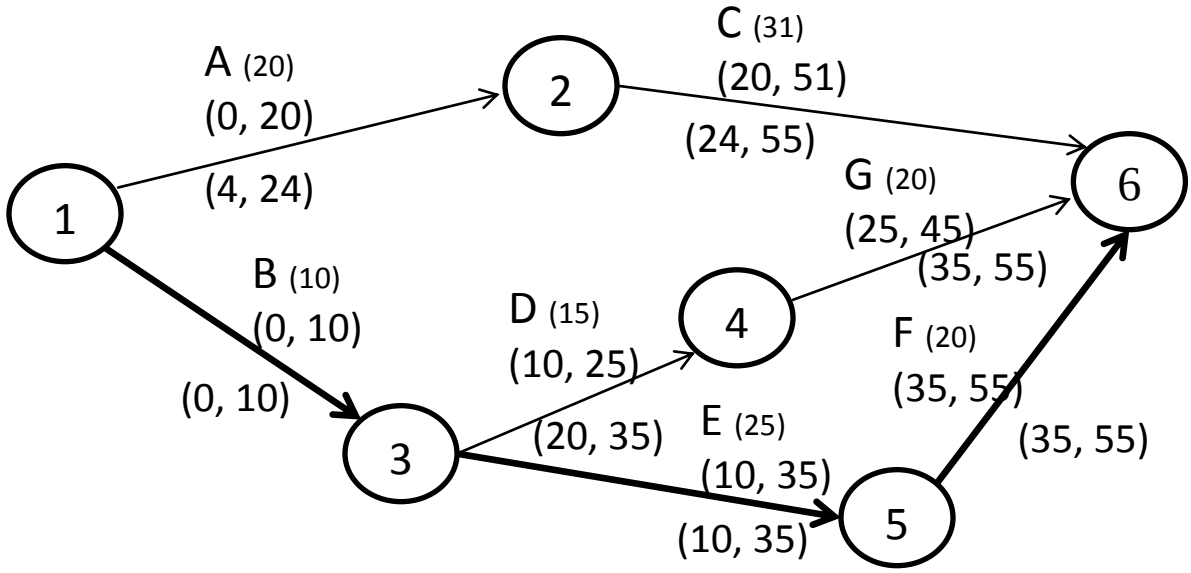
a) Draw the network diagram (expected time may be rounded to the nearest whole number)
b) Identify the critical path and
c) Determine the project duration.

ANS

(a) **Expected Time calculation**:

Activity	Immediate Predecessors	T_o	T_m	T_p	Expected Time T_e
A	-	15	20	25	20
B	-	8	10	12	10
C	A	25	30	40	30.8
D	B	15	15	15	15
E	B	22	25	23	24.8
F	E	15	20	22	19.5
G	D	20	20	22	20.3

a)Network PERT Diagram



b)**Critical Path : B-E-F**

c)Project Duration : 55 weeks

L3

A company has got following two investment options:

Option A:. Investment envisaged Rs. 40 lakhs with an annual return of Rs. 8 lakhs; Life of the project is 10 years

Option B: Investment envisaged Rs. 24 lakhs; Annual return Rs. 5 lakhs; Life of the project is 8 years

Calculate IRR of both the options and suggest which option the company should select.

	Option A: Investment = Rs. 40 lakh Annual Return = Rs. 8 lakh Life of project = 10 years $0 = [(-) 40 \times 10^5] + [(8 \times 10^5) / (1 + 0.15)^1] + [(8 \times 10^5) / (1 + 0.15)^2] + ---------- + [(8 \times 10^5) / (1 + 0.15)^9] + [(8 \times 10^5) / (1 + 0.15)^{10}]$ **= 15.12 %** Option B: Investment = Rs. 24 lakh Annual Return = Rs. 5 lakh Life of project = 8 years $0 = [(-) 24 \times 10^5] + [(5 \times 10^5) / (1 + 0.13)^1] + [(5 \times 10^5) / (1 + 0.13)^2] + ---------- + [(5 \times 10^5) / (1 + 0.13)^7] + [(5 \times 10^5) / (1 + 0.13)^8]$ **= 13.04 %** Based on IRR, the Option A has higher IRR value and the company may opt for Option A.
L4	Write short note on **any two** of the following a) Energy Service Companies (ESCOs) b) Sensitivity analysis for financing of energy conservation projects c) Sankey diagram
Ans	a) **Energy Service Companies** (ESCOs) : page -171 ESCOs are usually companies that provide a complete energy project service, from assessment to design to construction or installation, along with engineering and project management services, and financing. Depending on the company's capability to manage the risks (equipment performance, financing, etc.) the company will delegate some of these responsibilities to the ESCO. In general, the amount of risk assigned to the ESCO is directly related to the percent savings that must be shared with the ESCO. *For example, a lighting retrofit has a high probability of producing the expected cash flows, whereas a completely new process does not have the same "time tested" reliability. If the in-house energy management team cannot manage this risk, performance contracting may be an attractive alternative*. The ESCO will usually offer the following common types of contracts: • Fixed fee • Shared savings

- Guaranteed savings

Services offered by an ESCO usually include:

- ✓ An investment grade energy audit to identify energy and operational savings opportunities, assess risks, determine risk management/mitigating strategies, and calculate cost-effectiveness of proposed measures over time.
- ✓ Financing from its own resources or through arrangements with banks or other financing sources.
- ✓ The purchase, installation and maintenance of the installed energy efficient equipment; possibly maintenance on all energy-consuming equipment.
- ✓ New equipment training of operations and maintenance (O&M) personnel.
- ✓ Training of O&M personnel in energy-efficient practices.
- ✓ Monitoring of the operations and energy savings, so reduced energy consumption and operation costs persist.
- ✓ Measurement and savings verification; and
- ✓ A guarantee of the energy savings to be achieved.

b) Sensitivity analysis for financing of energy conservation projects : (page168 -169)

Many of the cash flows in the project are based on assumptions that have an element of uncertainty. The cash flows such as capital cost, energy cost savings, maintenance costs can usually be estimated fairly accurately. Even though these costs can be predicted with some certainty, it should always be remembered that they are only estimates. Cash flows in future years normally contain inflation components and project life itself can vary significantly.

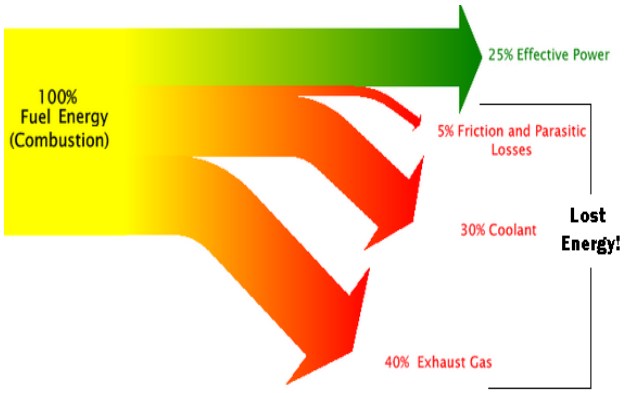
Sensitivity analysis is an assessment of risk. Because of the uncertainty in assigning values to the analysis, it is recommended that a sensitivity analysis be carried out - particularly on projects where the feasibility is marginal. How sensitive is the project's feasibility to changes in the input parameters? What if one or more of the factors in the analysis is not as favourable as predicted? How much would it have to vary before the project becomes unviable? What is the probability of this happening?

Sensitivity analysis is undertaken to identify those parameters that are both uncertain and for which the project decision taken through the NPV or IRR is sensitive. The effect of switching values of key variables required for the project decision (from acceptance to rejection) can be compared with the post evaluation results of similar projects. Sensitivity and risk analysis should lead to improved project design, with mitigation actions against major sources of uncertainty involved.

The various micro and macro factors / variables that are considered for the sensitivity analysis are listed below.

Micro factors:

- ✓ Operating expenses (various expenses items)
- ✓ Capital structure
- ✓ Costs of debt, equity
- ✓ Changing of the forms of finance e.g. leasing
- ✓ Changing the project life

	Macro factors: Macro economic variables are the variable that affects the operation of the industry of which the company operates. They cannot be changed by the firm's management. Macro economic variables, which affect projects, include among others: ✓ Changes in interest rates ✓ Changes in the tax rates ✓ Changes in the accounting standards e.g. methods of calculating depreciation ✓ Changes in depreciation rates ✓ Extension of various government subsidized projects e.g. rural electrification ✓ General employment trends e.g. if the government changes the salary scales ✓ Imposition of regulations on environmental and safety issues in the industry ✓ Energy price change ✓ Technology changes c) **Sankey diagram**: (page - 127) The Sankey diagram is very useful tool to represent an entire input and output energy flow in any energy equipment or system such as boiler generation, fired heaters, furnaces after carrying out energy balance calculation. Usually the flows are represented by arrows. The width of the arrows is proportional to the size of the actual flow. Better than numbers, tables or descriptions, this diagram represents visually various outputs (benefits) and losses so that energy managers can focus on finding improvements in a prioritized manner. The Figure shows a Sankey diagram for an internal combustion engine. From the Figure, it is clear that exhaust flue gas losses are a key area for priority attention. Since the engines operate at high temperatures, the exhaust gases leave at high temperatures resulting in poor system efficiency. Hence a heat recovery device such as a waste heat boiler has to be necessarily part of the system. The lower the exhaust temperature, higher is the system efficiency.  **Sankey Diagram for an Internal Combustion Engine**
L5	a) Calculate the annual energy savings and simple payback from replacing standard existing motor with energy efficient motor versus rewinding the existing motor. The data given: • Average cost of rewinding =Rs 6500 • Cost of new high efficient motor =Rs 37000 • Efficiency after rewound of standard motor =87% • Efficiency of energy efficient motor = 94% • Operating hours = 7200 hrs

	• % loading of motor = 82% • Power cost = Rs 5.2 / kWh • Name plate rating of motor = 20 kW b) During an air pollution monitoring study, the inlet gas stream to a bag filter was 200,000 m^3 per hour. The outlet gas stream from the bag filter was little bit higher at 220,000m^3 per hour. The dust load at the inlet was 5 g/m^3 and at the outlet 0.2 g/m^3. How much dust in kg/hour was collected in the bag filter bin?
	a) Solution: Energy cost savings (Rs/year) =[(KW)*(% loading)*{(100/efficiency of rewound standard motor)-(100/efficiency of energy efficient motor)}*(Hrs/annum)*(Rs/kwh)] = 20*0.82*7200*[(100/87)-(100/94)]*5.2 =118080*[1.1494-1.0638]*5.2 =52560/- Simple payback period = [(Rs 37000-Rs 6500)/52560] = 7 months b) Dust (gas in) = dust (in gas out) + dust (in bin) 200000 x 5 = 220000 x 0.2 + X X = 1000000 – 44000 = 956000 gm/hr **= 956 Kg/hr**
L6	Write short note on **<u>any two</u>** of the following. a) 5S b) KAIZEN c) ISO 50001 d) TPM
Ans	**a) 5S**: (page-145) 5S, abbreviated from the Japanese words **Seiri, Seiton, Seiso, Seiketsu, and Shitsuke**, are simple but effective methods to organize the workplace. The 5S, translated into English are: **housekeeping, workplace organization, cleanup, maintain cleanliness, and discipline**. They can be defined as follows: • **Housekeeping.** Separate needed items from unneeded items. Keep only what is

immediately necessary item on the shop floor.

- **Workplace Organization.** Organize the workplace so that needed items can be easily and quickly accessed. A place for everything and everything in its place.
- **Cleanup.** Sweeping, washing, and cleaning everything around working area immediately.
- **Cleanliness.** Keep everything clean in a constant state of readiness.
- **Discipline.** Everyone understands, obeys, and practices the rules when in the plant.

Implementing 5S methods in the plant would help the company to reduce waste hidden in the plant, improve the levels of quality and safety, reduce the lead time and cost, and thus increase Company's **profit**.

b) KAIZEN: (page -147)

"KAIZEN", is a practice developed by Japanese for increasing productivity. KAIZEN is the Japanese word made up of two components.

KAI – Change
ZEN – Good (for the better)
KAIZEN – Change for the better or continuous improvement.

KAIZEN means continuous improvement involving everyone – Managers and Workers alike. It emphasizes improvement on working standard through small, gradual improvement. Its philosophy assumes that our way of working life, our social life or our human life – deserves to be constantly improved.

Kaizen events focuses on reducing various forms of wastes and often energy reduction result from projects that focus on an area or a process. For example, a project that was implemented to reduce colouring chemicals in a plastic industry resulted in small changes in plant layout and material flow to its use. This ended up in big reduction in amount of forklift travelled and fuel used in the forklift.

Implementation:

Step-1: Identification of a problem, i.e. waste, defect or something not working. The operator writes and describes the problem
Step-2: Operator later develops an improvement idea and goes to immediate supervisor
Step-3: Supervisor / Kaizen team members review it and encourage immediate action and fills up the Kaizen form
Step-4: The idea is implemented & checked.
Step-5: The operator is rewarded.

c) ISO 50001: (page -151)

ISO 50001 will establish a framework for industrial plants, commercial facilities or entire organizations to manage energy. The document is based on the common elements found in all of ISO's management system standards, assuring a high level of compatibility with ISO 9001 (quality management) and ISO 14001 (environmental management).

Energy Management System enables an organization to take a systematic approach in order to achieve continual improvement of energy performance, energy efficiency and

energy conservation.

An energy management system addresses:

- Energy supply;
- Measurement;
- Documentation and reporting of energy use; and
- Procurement & design practices for energy-using equipment, systems and processes.

To simply put it, ISO 50001 is "*saying what you do and doing what you say".*

d) TPM : (page -148)

Total productive maintenance (TPM) is the method that focuses on optimizing the effectiveness of manufacturing equipment. TPM builds upon established equipment-management approaches and focuses on team-based maintenance that involves employees at every level and function.

The goal of TPM is to build a robust organisation by maximizing production system efficiency (overall effectiveness).

- TPM addresses the entire production system lifecycle and builds a concrete, shop floor-based system to prevent all losses. It aims to eliminate all accidents, defects, and breakdowns.
- TPM involves all departments from production to development, sales, and administration.
- Everyone participates in TPM, from the top executive to shop floor employees.
- TPM achieves zero losses through overlapping team activities.

-------- End of Section - III ---------