Paper 1 Code : GREEN

20th NATIONAL CERTIFICATION EXAMINATION FOR ENERGY MANAGERS & ENERGY AUDITORS – September, 2019

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

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

1.	Which of the following statement is true regarding the EC act? a) **Designated consumers have to appoint Energy managers with prescribed qualifications.** b) State Designated Agencies have to appoint Energy auditor with prescribed qualifications. c) Designated consumer has to get an energy audit conducted by a certified energy Manager. d) Designated consumer has to get an energy audit conducted by the State Designated Agency
2.	Which of the following statements regarding evacuated tube collectors (ETC) are true? i) ETC can reach high temperatures upto 150°C ii) because of vacuum between two concentric glass tubes, 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) i & ii**
3.	How much power you would expect to generate from a river-based mini hydropower with flow of 40 litres/second, head of 12 metres and system efficiency of 55%. a) 872 kW **b) 2.59 KW** c) 264 kW d) none of the above
4.	Which among the following has the highest flue gas loss on combustion due to Hydrogen in the fuel? **a) Natural gas** b) furnace oil c) coal d) light diesel oil
5.	Energy in one Tonne of Oil Equivalent (toe) corresponds to a) 4.187 GJ b) 1.162 MWh c) 10,000 kcal **d) none of the above**
6.	Assume CO_2 equivalent emissions by the use of a 40 W fluorescent lamp are of the order of 60 g/hr. If it is replaced by a 20 W LED lamp then the equivalent CO_2 emissions will be a) nil, as LED does not emit CO_2 **b) 30 g/hr** c) 20 g/hr d) 1200 g/hr
7.	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) BEE
8.	Stroboscope is an instrument for measuring a) steam flow b) composition of flue gas c) **speed** d) pressure
9.	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 / TR d) **kW / TR**
10.	If 1 kWh of electrical energy is used to heat 10 kg of ice at 0° C, what will be the temperature of water after melting? (Latent heat of fusion of ice is 80 kcal/kg) a) 0°C **b) 6°C** c) 86°C d) none of the above
11.	If feed of 15 tonnes per hour at 6% concentration is fed to an evaporator, the product obtained at

	30% concentration is equal to ____ tonnes per hour. **a) 3** b) 9 c) 0.9 d) 4.5
12.	The discount rate is used as an input in determining _____. **a) NPV** b) IRR c) payback period d) all of the above
13.	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.
14.	The cost of an economizer is Rs. 2 lakhs. The simple payback period (SPP) in years considering annual savings of Rs 1,10,000 and annual maintenance cost of Rs 10,000 is _____. a) 1.8 b) 2.5 **c) 2** d) 0.5
15.	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
16.	In an industry the average electricity consumption is 10 lakh kWh for a given period. The average production is 90,000 tons with a specific electricity of 10 kWh/ton for the same period. The fixed electricity consumption for the plant is **a) 1,00,000 kWh** b) 9,90,000 kWh c) 10,000 kWh d) none of the above
17.	The cost of retrofitting a humidification system with an energy efficient one costs Rs. 20 lakhs. The net annual cash flow is Rs. 5 lakhs. The return on investment is _____. 18% **b) 25%** c) 15% d) 33.33%
18.	The theoretical amount of electricity required to heat 500 litres of brine solution with a specific gravity of 1.2 and specific heat of 1 kcal/kg K from 30^{o}C to 70 ^{o}C through resistance heating is_____ a) **27.9 kWh** b) 23.3 kWh c) 20 kWh d) none of the above
19.	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**
20.	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_____. 576000 kcal b) 472320 kcal c) **103680 kcal** d) 480000 kcal
21.	Which of the following is true? **a) The internal rate of return is the discount rate for which the NPV is Zero** b) NPV is the internal rate of return for which the discount rate is Zero c) The discount rate is the internal rate of return for which NPV is positive d) NPV is the discount rate for which internal rate of return is positive
22.	Having energy policy _____ a) satisfies regulations b) **shows top management commitment** c) indicates energy audit skills d) Ensures ISO 50001 certification
23.	Which of the following is **not true** of fuels cells? a) **they consume electricity** b) they are fuelled by hydrogen c) they have an electrolyte c) produce water and heat

24.	Which of the following has the highest Reserve to Production (R/P) ratio in India? a) Lignite b) Petroleum **c) Coal** d) Natural gas
25.	SI unit for energy is_____ a) Watt b) Kilogram c) Newton d) **Joule**
26.	Which of the following has the lowest energy content in terms of MJ/kg? a) LPG b) Diesel c) Furnace Oil d) **Coal**
27.	Which of the following industries has the highest Specific Electrical Energy Consumption? **a) Aluminum** b) Sugar c) Paper & Pulp d) Cement
28.	Select the wrong statement. a) Energy Efficiency and Energy Conservation are distinct and interrelated b) **Unscheduled power interruption is an Energy conservation measure** c) Productivity improvements leads to energy conservation d) Energy Efficiency is an integral part of energy conservation
29.	_____ in Centre and_____ _ in States are mandated to implement the provisions of The Energy Conservation Act, 2001 a) BEE and NPC b) BEE and DISCOM c) BEE and SERC d) **BEE and SDA**
30.	Energy Conservation Building Code (ECBC) sets; **a) Minimum Energy Efficiency Standards for design and Construction of Buildings** b) Green Building Rating System c) Municipal DSM Regulations d) Incentives for energy efficient buildings
31.	Which of the following is one of the schemes of BEE under Energy Conservation Act ? **a) Standards and Labelling** b) Availability based Tariff c) Standard of Performance of DISCOMs d) Renewable Energy Certificates
32.	Which one of the following is **not** a Designated Consumer category under PAT ? a) Paper and Pulp Industries b) Cement Plants c) Chlor Alkali Plants d) **Sugar Plants**
33.	Steam contains 10% moisture by mass, its dryness fraction x is _____. 0.1 b. 1 c. **0.9** d. None of the above

34.	Which of the following has highest Global Warming Potential? a) **SF_6** b) CO_2 c) CH_4 d) N_2O
35.	Which of the following is **not** true? a) Primary energy is converted to secondary energy in industries **b) Secondary energy is converted to primary energy in industries** c) Coal is primary energy d) Electricity is secondary energy
36.	Which primary energy is used as a feedstock in fertilizer industry? a) Steam **b) Natural gas** c) Electricity d) All of the above
37.	Bio-gas generated through anaerobic process mainly consists of a) only methane b) M**ethane and carbon dioxide** c) only ethane d) only carbon dioxide
38.	Which of the following statements are true? i) Rice husk is a source of secondary energy ii) nuclear energy is non-renewable 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)
39.	Trillion cubic meters is a unit normally used for a) Crude oil b) Lignite c) Bituminous coal d) **Natural Gas**
40.	Which of the following will have maximum value when expressed as MTOE (Metric Tonne of Oil Equivalent)? a) **1000 tonnes of furnace oil** **b)** 10,000 kWh of electrical energy b) 1000 tonnes of bituminous coal d) 1000 tonnes of lignite
41.	Which of the following is **not true** of natural gas? a) **Requires more excess air compared to oil** b) Consists mainly of methane c) Becomes liquefied when cooled to -161^oC d) All of the above
42.	In a boiler, substitution of coal with rice husk will definitely lead to_____. a) energy conservation b) energy efficiency c) both energy conservation and energy efficiency **d) GHG reduction**
43.	For determining the Energy intensity at the national level, which of the following are **not required?** (i) Gross domestic product (ii) Total final consumption, (iii) R/P ratio in years (iv) Prevailing prices of various fuels a) (i) & (iv) b) (i) & (ii) **c) (iii) & (iv)** d) (i) & (iv)
44.	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) connected load is 100 kW and above or contract demand is 120 kVA and above** d) connected load is 500 kW and contract demand is 600 kVA
45.	Which of the following is true of DSM?

	a) results in energy and/or demand reduction b) enables end-users to better manage their load curve c) can improve the profitability of power supply company **d) All of the above**
46.	An induction motor with 11 kW rating and a rated power factor of 0.9 in its name plate means a) it will draw 12.22 kW at full load b) it will draw 11 kW at full load c) it will draw 9.9 kW at full load **d) it will deliver 11 kW at full load**
47.	The unit used for determining a designated consumer is _____. a) million tonnes of oil equivalent per year b) metric tonnes of oil equivalent per month **c) metric tonnes of oil equivalent per year** d) million tonnes of oil equivalent per month
48.	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**
49.	Global warming will **not** result in_____ a) melting of the ice caps b) increasing sea levels **c) severe damage to ozone layer in stratosphere** d) unpredictable climate patterns
50.	The process of capturing CO_2 from point sources and storing them is called _____. a) **carbon sequestration** b) carbon sink c) carbon Capture d) carbon absorption

……. End of Section – I …….

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

Each question carries **Five** marks

S1	An industry intends to invest Rs. 5,00,000 in a new energy saving project. The cash flows expected are: Year 1 : Rs.2,00,000 Year 2 : Rs.3,00,000 Year 3 : Rs.2,00,000 The expected return is 10%. Evaluate the Net Present Value and comment on the feasibility of the project? **Solution:** NPV = {-500,000+(200,000/1.10)+[300,000/$(1.1)^2$]+[200,000/$(1.1)^3$]} = (-500,000+181818+247934+150263) = 80015 NPV is positive Rs. 80,015; therefore, the proposed investment for the new energy saving project is viable and attractive.

S2	Write short note on **<u>any one</u>** of the following. a) ISO 50001 **(Book 1 - Page 157 & 158)** b) Energy Security (**Book 1 - Page 20 to 22)**
S3	A continuous centrifuge separates 36,000 kg of whole milk containing 4% fat in 6-hour period into skim milk with 0.40% fat and cream with 40 % fat. Find out the flow rates of whole milk, cream and skim milk using mass balance. **Ans:** **Mass in** Total mass flow of whole milk = 36000/6 = 6000 kg per hour. Fat per hour = 6000 x 0.04 = 240 kg/hr. Therefore, Water plus solids other than fat = (6000-240) kg per hr. = 5760 kg per hr. **Mass out :** Let the mass of cream be X kg then its total fat content is 0.40X. The mass of skim milk is (6000 - X) and its total fat content is 0.0040 (6000 - X) **Material balance on fat:** Fat in = Fat out 6000 x 0.04 = 0.0040(6000 - X) + 0.40X; solving this, X = 545 kg/hr So that the flow of cream is 545 kg / hr and skim milk (6000- 545) = 5455 kg/hr.
S-4	A water pumping station fills a tank at a fixed rate. The head and flow rate are constant and hence the power drawn by the pump is always same. The pump delivers 80 litres per second. The power consumption was measured as 84 kW. Calculate the energy consumption for pumping 2880 kL of water to the reservoir.
Ans	Time taken to pump water in hours = $\frac{(2880 \times 10^3 \text{ lit})}{(80 \text{ lit/s} \times 3600 \text{ sec/hr})}$ = 10 hours Power required to pump water = 84 kW Energy consumption = 84 x 10 hrs = 840 kWh
S-5	A conveyor delivers coal with a width of 0.9 m and coal bed height of 0.15 m at a speed of 0.8 m/s. Determine the coal delivery in tons per hour considering the coal density as 1.1 ton/m^3.
Ans	Volume of coal delivered per hour = Area x Length travelled per second = 0.9 m x 0.15 m x 0.8 m/s

	= 0.108 m^3/s = 0.108 x 3600 = 388.8 m^3/hr Coal delivery rate = 388.8 m^3/hr x 1.1 t/m^3 = 427.7 tonnes/hr
S-6	In a textile industry, 25,000 kg/hr water is currently being heated from 28 ^oC to 80 ^oC by indirect heating of steam in dyeing machines. It is proposed to recover heat from the hot effluent and generate hot water at 45 ^oC which would be further raised to 80 ^oC by steam. Estimate the reduction in steam in kg/hr considering the latent heat of steam as 520 kcal/kg in both the cases.
Ans	**Ans:** **Without heat recovery** Heating required (Q_1) = $mC_p\Delta T$ = 25000 x 1 x (80-28) = 13,00,000 kcal/hr Steam required = 13,00,000 / 520 = 2500 kg/hr **After heat recovery** Heating required (Q_2) = 25000 x 1 x (80 – 45) = 8,75,000 kcal/hr Steam required = 8,75,000 / 520 = 1682.7 kg/hr Reduction in steam required = 2500 - 1682.7 = 817.3 kg/hr
S7	Briefly explain the difference between flat plate collector and evacuated tube collector. **(Book 1, Page 264-265)**
S8	a) What is solar constant and solar insolation? **(3 Marks)** b) Which of them determines the amount of electrical energy that can be produced per unit area of solar panel on any given day? **(2 Marks)** **(Book 1, Page 263 – 264)**

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

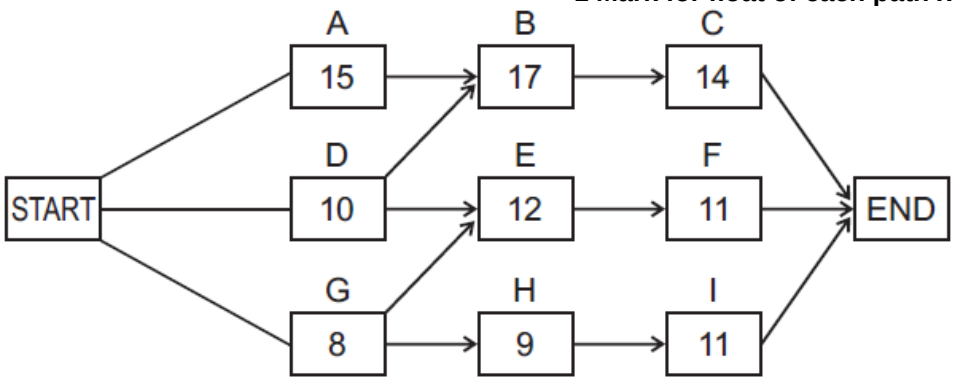
Section – III: LONG DESCRIPTIVE QUESTIONS Marks: 6 x 10 = 60

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

L1	a) A sample of fuel being used in a boiler is found to contain 40% carbon and 23% ash. The refuse obtained after combustion is analyzed and found to contain 7% carbon & the rest is ash. Compute the percentage of the original carbon in fuel which remains as unburnt in the refuse. (5 Marks) b) During an ESP performance evaluation study, the inlet gas stream to ESP is 2,89,920 Nm3/hr and the dust loading is 5,500 mg/ Nm3. The outlet gas stream from ESP is 3,01,100 Nm3/hr and the dust loading is 110 mg/Nm3. How much fly ash is collected in the system in kg/hr? (5 Marks)
	a) 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 fuel that has come into the Refuse = 23% of fuel 93 kg of Ash corresponds to 23% ash in the fuel Therefore, quantity of total raw fuel = 93 / 0.23 = 404.35 kg Quantity of original Carbon in the fuel = 0.40 x 404.35 = 161.74 kg Quantity of unburnt fuel in Refuse = 7 kg %age of the original carbon unburnt in the refuse = (7 / 161.74) x 100 = 4.32% b) Based on Mass balance, Inlet gas stream dust = Outlet Gas stream dust + Fly ash i) Inlet gas stream flow = 289920 NM3/hr Dust Concentration = 5500 mg/NM3 Inlet dust quantity = 289920 x 5500 / 1000000 = 1594.56 kg/hr ii) Outlet dust quantity = 301100 (NM3/hr) x 110 (mg/NM3) x 1 / 1000000 = 33.12 kg/hr iii) Fly Ash = Inlet gas stream dust – Outlet gas stream dust = 1594.56 – 33.12 = 1561.44 kg/hr
L2	Write short note on **<u>any two</u>** of the following. (Each 5 Marks) a) Benchmarking, **(Book 1, Page 98 – 100)** b) DSM, **(Book 1, Page 38)** c) TPM, **(Book 1, Page 154 – 155)**

L3 Based on the following network diagram, identify the total number of paths with duration, critical path, and float for each path.

1 Mark each path x 5 = 5 Mark
1 Mark for identifying critical path = 1 Mark
1 Mark for float of each path x 4 = 4 Mark



Solution:

The above network diagram has five paths; the paths and their duration are as follows:

Start -> A -> B -> C-> End, duration: 46 days.
Start ->D -> E ->F -> End, duration: 33 days.
Start -> D -> B -> C -> End, duration: 41 days.
Start -> G ->H ->I -> End, duration: 28 days.
Start -> G -> E ->F -> End, duration: 31 days.

Since the duration of the first path given below is the longest, it is the critical path.

Start -> A -> B -> C-> End, duration: 46 days.

The float on the critical path is zero.

The float for the second path "Start ->D -> E ->F -> End" =
Duration of the critical path – duration of the path "Start ->D -> E ->F -> End" = 46-33 = 13
Hence, the float for the second path is 13 days.

Using the same process, we can calculate the float for other paths as well.
Float for the third path = 46 – 41 = 5 days.
Float for the fourth path = 46 – 28 = 18 days.
Float for the fifth path = 46 – 31 = 15 days.

L4 In the washing process of an automobile plant, electricity is being used to heat 5000 litres/hr of water by 8 ^{0}C. The industry is planning to convert from Electrical heating to LPG heating.

Other Parameters:

Annual operating hours	= 6000 hours
Efficiency of indirect heating with LPG	= 85%
Efficiency of electrical heating	= 95%
Calorific value of LPG	= 12,000 kcal/kg
Landed cost of LPG	= Rs.60/kg
Cost of electricity	= Rs.8/kWh

a) If electrical heating is replaced with LPG heating, with an investment is Rs.15 lakhs, compute the simple payback period. (6 Marks)
b) Also, calculate the CO_2 emissions in both the cases considering the emission factors for LPG as 3

	tons of CO_2/Ton of LPG and Electricity as 0.81 tons of CO_2/MWh. (4 Marks)
Ans	a). Water flow rate = 5000 Litres/hr Temperature rise = 8 ^oC Useful Heat Required = (5000 x 1 X 8) = 40,000 kcal/hr Equivalent LPG consumption = 40000/(12000 x 0.85) = 3.92 kg/hr Hourly Cost of Operating with LPG = 3.92 x 60 **= Rs.235 / hr** Equivalent electricity consumption = 40000/ (860 * 0.95) = 48.96 kW Hourly Cost of operating with electricity = 48.96 x 8 **= Rs.391.68/ hr** Difference in hourly operating cost = Rs. (391.68 – 235) = Rs.156.68/ hr Annual monetary savings = Rs.156.68/ hr x 6000 hrs/yr = Rs.9,40,080/ yr Investment = Rs.15,00,000 Simple payback period = Rs. 15,00,000/ Rs.9,40,080/ yr = 1.6 yr a) Annual CO_2 Emission with electrical heating = 48.96 kW x 6000 x (0.81 kg CO_2/kWh) = 237946 kg CO_2/ yr = 237.95 tonnes CO_2/ yr Annual CO_2 emission with LPG heating = 3.92 kg LPG/hr x 6000 hr/yr x (3 kg CO_2/kg LPG) = 70560 kg CO_2/yr = 70.6 tonnes CO_2/yr Thus, by converting from electricity to LPG use, there is a huge advantage, not only in operating cost but also in reduced CO_2 emissions.
L5	A company has got the following two energy saving project investment options: <u>Option A:</u> Investment envisaged is Rs. 40 lakhs with an annual return of Rs. 12 lakhs; life of the project is 5 years. Calculate IRR. <u>Option B</u>: A project having IRR of 12% **Which option should the company select?**
	<u>Option A:</u> Investment = Rs. 40 lakh Annual Return = Rs. 12 lakh Life of project = 5 years 0 = (-) 40 + (12) [1/ $(1 + i)^1$ + 1/ $(1 + i)^2$ + 1/ $(1 + i)^3$ + 1/ $(1 + i)^4$ + 1/ $(1 + i)^5$] IRR **= 15.24 %** Based on IRR, the Option A has higher IRR value and the company may opt for Option A.

L6 Match the following:

1.	Biomass	a.	Radiation
2.	CNG	b.	Distribution Loss Reduction
3.	HVDS	c.	Oxidation
4.	Cement	d.	Sankey Diagram
5.	Combustion	e.	ISO 50001
6.	Energy Balance	f.	Designated consumer
7.	kWh/ton of product	g.	Transport
8.	Objectives, targets & action plans	h.	Carbon neutral
9.	Performance Contracting	i.	Benchmarking
10	Surface Heat Loss	j.	ESCO

(Each 1 Mark)

Solution:

1. Biomass : Carbon neutral
2. CNG : Transport
3. HVDS : Distribution Loss Reduction
4. Cement : Designated consumer
5. Combustion : Oxidation
6. Energy Balance : Sankey Diagram
7. kWh/ton of product : Benchmarking
8. Objectives, targets & action plans : ISO 50001
9. Performance Contracting : ESCO
10. Surface Heat Loss : Radiation

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