

Sustainable and Renewable Energy Development Authority
(SREDA)

Power Division, Ministry of Power, Energy and Mineral Resources

4th Energy Auditor Certification Examination-2023

Paper- 1

Candidate's Roll No.

2 0 2 3 0 5

Examinee's Name _____

A

Paper 1: Fundamentals of Energy Management and Energy Audit

Total Marks- 150, Time- 3.00 Hours, Date: 23 May 2023

• **Important Instruction:**

1. This Paper has 50 MCQs + 8 Short Questions + 6 Long Questions = Total 64 Questions.
2. Mark indicated on the right side of each question.
3. Fill in correct circle with permanent ink ballpoint pen shown on the top sheet only corresponding to the MCQ given in Section A.
4. Answer in the blank space provided after each question (short/long).
5. Do not put any sign or write anything on the answer script except written answer.
6. Any unfair means, peer talking, keeping any communication device and misbehavior will lead to cancellation of examination.

MCQ Answer (Section A):

1	(A)	(B)	(C)	(D)	18	(A)	(B)	(C)	(D)	35	(A)	(B)	(C)	(D)
2	(A)	(B)	(C)	(D)	19	(A)	(B)	(C)	(D)	36	(A)	(B)	(C)	(D)
3	(A)	(B)	(C)	(D)	20	(A)	(B)	(C)	(D)	37	(A)	(B)	(C)	(D)
4	(A)	(B)	(C)	(D)	21	(A)	(B)	(C)	(D)	38	(A)	(B)	(C)	(D)
5	(A)	(B)	(C)	(D)	22	(A)	(B)	(C)	(D)	39	(A)	(B)	(C)	(D)
6	(A)	(B)	(C)	(D)	23	(A)	(B)	(C)	(D)	40	(A)	(B)	(C)	(D)
7	(A)	(B)	(C)	(D)	24	(A)	(B)	(C)	(D)	41	(A)	(B)	(C)	(D)
8	(A)	(B)	(C)	(D)	25	(A)	(B)	(C)	(D)	42	(A)	(B)	(C)	(D)
9	(A)	(B)	(C)	(D)	26	(A)	(B)	(C)	(D)	43	(A)	(B)	(C)	(D)
10	(A)	(B)	(C)	(D)	27	(A)	(B)	(C)	(D)	44	(A)	(B)	(C)	(D)
11	(A)	(B)	(C)	(D)	28	(A)	(B)	(C)	(D)	45	(A)	(B)	(C)	(D)
12	(A)	(B)	(C)	(D)	29	(A)	(B)	(C)	(D)	46	(A)	(B)	(C)	(D)
13	(A)	(B)	(C)	(D)	30	(A)	(B)	(C)	(D)	47	(A)	(B)	(C)	(D)
14	(A)	(B)	(C)	(D)	31	(A)	(B)	(C)	(D)	48	(A)	(B)	(C)	(D)
15	(A)	(B)	(C)	(D)	32	(A)	(B)	(C)	(D)	49	(A)	(B)	(C)	(D)
16	(A)	(B)	(C)	(D)	33	(A)	(B)	(C)	(D)	50	(A)	(B)	(C)	(D)
17	(A)	(B)	(C)	(D)	34	(A)	(B)	(C)	(D)					

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MCQ	:	[]	
Short Question	:	[]	
Long Question	:	[]	
Total Marks	:	[]	Signature of Examiner

Do not write or mark anything in this page

Section A: MCQ

Fill the appropriate circle in the OMR answer sheet at the top page.

1 x 50 =50

- 1 The simplest technique for scheduling of tasks and tracking the progress of energy management projects is called
 - A) Gantt chart
 - B) CPM
 - C) PERT
 - D) WBS
- 2 The Metric Tons of Oil Equivalent (MTOE) value of 125 tons of coal having GCV of 4000 kCal/kg is
 - A) 40
 - B) 50
 - C) 100
 - D) none of the above
- 3 Benchmarking helps to
 - A) track performance change over time
 - B) compare with best/average performance
 - C) both a & b
 - D) none of the above
- 4 Which of the following is the predominant loss in a furnace oil fired boiler?
 - A) dry flue gas losses
 - B) heat loss due to moisture in air
 - C) heat loss due to radiation and convection
 - D) heat loss due to moisture in fuel
- 5 Energy supplied by electricity, Q in kCal is equal to _____
 - A) kWh x 8.6
 - B) kWh x 86
 - C) kWh x 860
 - D) None of the above
- 6 Energy monitoring and targeting is built on the principle of “_____”.
 - A) “production can be reduced to achieve reduced energy consumption”
 - B) “Consumption of energy is proportional to production rate”
 - C) “You cannot manage what you do not measure”
 - D) None of the above.
- 7 A CUSUM graph follows a random fluctuation trend and oscillates around.
 - A) 100
 - B) 100%
 - C) 0
 - D) None of the above
- 8 A list of instruments and what they measure are given below. Which pair is incorrect in this list
 - A) Gas Analyzer-CO
 - B) Manometer-Pressure
 - C) Tachometer-Speed
 - D) Lux Meter-Lumens
- 9 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) HSD

- 10 Which of the following has the highest specific heat?
- A) Copper
B) Alcohol
C) Iron
D) Water
- 11 Stroboscope is used to measure
- A) Flow
B) Speed
C) Oxygen
D) Humidity
- 12 Which one is not a mandatory agenda for a management review meeting as per ISO 50001:2018
- A) Status of non-conformities
B) Internal Audit Result
C) External Audit Result
D) Status of Action Plan
- 13 The power generation potential in mini hydro power plant for a water flow of $3 \text{ m}^3/\text{s}$ with a head of 14 meters and with a system efficiency of 55% is
- A) 226.6 kW
B) 76.4 kW
C) 23.1 kW
D) None of the above
- 14 Red wood seconds is a measure of
- A) Density
B) Viscosity
C) Specific gravity
D) Flash Point Gas
- 15 Energy Intensity is the ratio of
- A) Fuel Consumption / GDP
B) GDP/Fuel Consumption
C) GDP/ Energy Consumption
D) Energy Consumption / GDP
- 16 Doppler effect principle is used in the following instrument
- A) lux meter
B) ultrasonic flow meter
C) infrared thermometer
D) flue gas analyser
- 17 Absolute Pressure is
- A) Gauge pressure
B) Gauge pressure + Atmospheric pressure
C) Atmospheric pressure
D) Gauge pressure - Atmospheric pressure
- 18 If we heat the air without changing absolute humidity, relative humidity (%) will-
- A) increase
B) decrease
C) no change
D) can't say
- 19 Fuel cell using methanol as anode and oxygen as cathode is
- A) proton exchange membrane fuel cell
B) phosphoric acid fuel cell
C) alkaline fuel cell
D) direct methanol fuel cell
- 20 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

- 30 Which of the following is true about sensitivity analysis?
 A) Higher the sensitivity, lower the risk of the project. C) Higher the sensitivity, higher the risk of the project.
 B) Higher the sensitivity, lower the value of the project. D) Higher the sensitivity, higher the value of the project.
- 31 Power and Harmonic analyzer is not used to measure
 A) Power factor C) Voltage
 B) Motor speed D) Frequency
- 32 Critical path identifies the
 A) Optimum time for a project C) Maximum time for a project
 B) Minimum time for a project D) Actual time for a project
- 33 If the optimistic, pessimistic and most likely time for a task is 4, 10 and 7 weeks respectively, what is the expected time?
 A) 10 C) 7
 B) 6 D) 8
- 34 Apart from Boilers and generators the largest energy consumed in industries is
 A) Lighting C) Air conditioner
 B) Motors D) Other services
- 35 The instrument used for measuring air velocity in ventilation is called:
 A) Thermo-anemometer C) Ultrasonic Flow Meter
 B) Thermo- hygrometer D) None of the above
- 36 Value of Betz limit is:
 A) 59% C) 39%
 B) 49% D) 29%
- 37 What is the energy conversion efficiency of a 175-watt hour solar panel that measures 0.75 X 1.50 meters, if the solar insolation is $1000\text{W}/\text{m}^2$?
 A) 12% C) 15%
 B) 13.6% D) 15.6%
- 38 When a 100 W electric bulb is connected to a 250V supply, the current flowing in the bulb is:
 A) 0.2A C) 0.3A
 B) 0.4A D) None of the above
- 39 Which of the following is not true for a preliminary energy audit
 A) estimate the scope for savings C) use existing or easily obtainable data
 B) identify low cost/no cost measures D) construct an energy balance
- 40 In a coal fired boiler, hourly consumption of coal is 1000 kg. The ash content in the coal is 30%. If the boiler operates 24 hours/day and 5% of the ash formed is carried away by the flue gas, the quantity of ash collected at the bottom of boiler per day will be:
 A) 6840 kg C) 1500 kg
 B) 7200 kg D) None of the above

- 41 What is the heat required to melt 2 kg of ice from zero degree to liquid water at zero degree in KJ?
- A) 672
B) 6000
C) 6048
D) 8374
- 42 When the current lags the voltage in an alternating current system, it is caused mainly due to
- A) resistive load
B) capacitive load
C) inductive load
D) None of the above
- 43 Which is a greenhouse gas
- A) Sulfur Dioxide
B) Nitrogen
C) Nitrous Oxide
D) None of the above
- 44 If feed of 100 tonnes with 40% moisture, is dried to 20% moisture, the amount of water vapour evaporated would be
- A) 20
B) 28
C) 30
D) 40
- 45 An indication of sensible heat content in air-water vapour mixture is
- A) wet bulb temperature
B) dew point temperature
C) density of air
D) dry bulb temperature
- 46 Which one is not an energy consumption benchmark parameter?
- A) kCal/kWh of electricity generated
B) kg/ deg C
C) kW/ton of refrigeration
D) kWh/kg of yarn
- 47 An electric heater consumes 1000 Joules of energy in 5 seconds. Its power rating is:
- A) 200 W
B) 1000 W
C) 5000 W
D) None of the above
- 48 An oil-fired boiler is retrofitted to fire coconut shell chips. Boiler thermal efficiency drops from 82% to 70%. What will be the percentage change in energy consumption to generate the same output
- A) 12% increase
B) 14.6% increase
C) 17.1% decrease
D) 17.1% increase
- 49 The primary energy content of fuels is generally expressed in terms of ton of oil equivalent (toe) and is based on the following conversion factor
- A) 1 toe= 10×10^6 kCal
B) 1 toe=11630 kWh
C) 1 toe=41870 MJ
D) All of the above
- 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

Section B: Short Question

- | | | Marks |
|----|--|-------|
| 01 | Calculate the boiler efficiency where the Turbine heat rate is 1930 kCal/kWh and the generating unit heat rate is 2250 kCal/kWh. | 5 |
| 02 | What is a Sankey diagram and what are its uses? Explain with an example. | 5 |
| 03 | What are the different phases of detailed energy audit and list down the aims of the preliminary site visit? | 5 |
| 04 | What are the 3-time estimate used for constructing PERT Network? One of the activities has 3 time estimate of 4 weeks, 5 weeks and 6 weeks in a PERT Network diagram. Find out the expected time to complete the activity and its variance of the activity
i) Three-time estimates are:
a) Optimistic time
b) Most likely time
c) Pessimistic time | 5 |
| 05 | Explain following terms in context of “Energy Management system”
i. Energy Performance Indicator.
ii. Energy Baseline | 5 |
| 06 | Find expected power output of a wind turbine having following specifications

Rotor Diameter= 6m
Coefficient of performance= 0.3
Generator efficiency =0.8
Gearbox efficiency 0.9
Assume:
Air density: 1.2 kg/m ³
Average Wind speed =11 m/s
Assume suitable values of necessary data (if required) | 5 |
| 07 | Consider a foundry which during a monitoring programme produces the following sample data: | 5 |

Month	Production, Tons/month	Energy Use, Tons/month
1	380	340
2	440	340
3	460	380
4	520	380
5	320	300
6	520	400
7	240	280
8	620	424
9	600	420

Use linear regression technique to predict Energy use when the production is 500 Tons.

- 08 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. 5

$$\text{Flow rate of whole milk} = \frac{36000}{6} = 6000 \text{ kg/hr}$$

Let, flow rate of cream = x

So as per mass balance, flow rate of skim milk= 6000-x

For fat

$$6000 \cdot 0.04 = (6000 - x) \cdot 0.004 + x \cdot 0.4$$

$$x = 545.45$$

$$6000 - x = 5454.55$$

Flow rate of skim milk = 5454.55 kg/hr

Flow rate of cream = 545.45 kg/hr

Section C: Long Question

- 01 ABC Company is considering implementation of one option out of three, (a) replacement of existing boiler with energy efficient once-through steam boiler, (b) installation of co-generation system, (c) installation of low-e pair glass and solar reflective glass, elevator with PM motor and LED lighting. Following are the cash flow scenario for each option. Marks
10

Options	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
A	(100,000)	27,500	27,500	27,500	27,500	27,500
B	(115,000)	30,000	30,000	30,000	30,000	30,000
C	(130,000)	35,000	35,000	35,000	35,000	35,000

Calculate NPV, Payback period and PI for all three options. Assume cost of capital is 10%. Which option the company should undertake?

- 02 A 500 MW coal plant based on conventional pulverized fuel has a gross efficiency of 38%. The Gross calorific value of the coal used is 4000 kCal/kg with 40% total carbon. A supercritical unit of 500 MW replaces the plant with a gross efficiency of 40% using the same characteristic coal. Calculate the following 2 x 5
- (a) Specific coal consumption after replacement
- (b) Amount of coal and carbon di-oxide saved during a year if the plant works for 8000 hours.

- 03 A project has the following activities, precedence relationships, and time estimates in weeks: 5+4+1

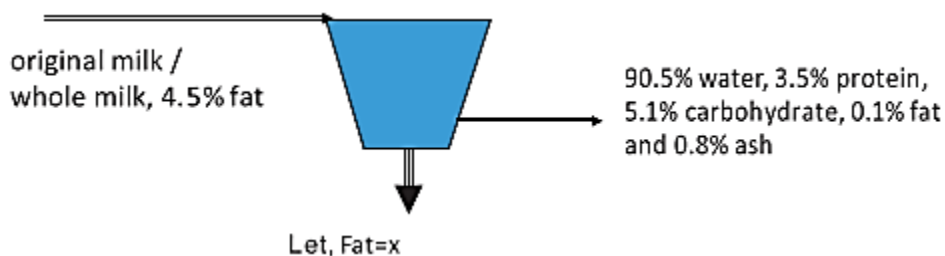
Activity	Immediate Predecessors	Optimistic Time	Most Likely Time	Pessimistic Time
A	-	15	20	25
B	-	8	10	12
C	A	25	30	40
D	B	15	15	15
E	B	22	25	27
F	E	15	20	22
G	D	20	20	22

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

- 04 In a food processing plant, the monthly production related variable energy consumption was 1.9 times the production and the non-production related fixed energy consumption was 1400 kWh per month up to December of the previous year. In the month of January, a series of energy conservation measures were implemented. Using CUSUM technique, develop a table and calculate the energy savings for the subsequent 6 months period up to the month of June from the data given below. 10

Month	Production (Kg)	Actual Energy Consumption
Jan	62000	113600
Feb	71000	139000
Mar	75000	158000
Apr	59000	119300
May	62000	123700
Jun	73000	143600

- 05 Skim milk is prepared by the removal of some of the fat from whole milk. This skim milk is found to contain 90.5% water, 3.5% protein, 5.1% carbohydrate, 0.1% fat and 0.8% ash. If the original milk contained 4.5% fat, calculate its composition assuming that fat only was removed to make the skim milk and that there are no losses in processing. 10



- 06 a) Two induction motors are running simultaneously are fed from a single source. Motor 1 is rated 415V, 3 phase, 20kVA, 0.8 PF. Motor -2 is rated 415V, 3 phase, 10 kVA, 0.9 PF. If the grid voltage is 415V, find the value of real power and line current drawn from the source. 2 x 5
- b) Briefly describe Plan-Do-Check-Act (PDCA) cycle.