

Sustainable and Renewable Energy Development Authority
(SREDA)

Power Division, Ministry of Power, Energy and Mineral Resources

4th Energy Auditor Certification Examination-2023

Paper- 3

Candidate's Roll No.

2 0 2 3 0 5

Examinee's Name _____

A

Paper 3: Energy Efficiency in Electrical Systems
Total Marks- 150, Time- 3.00 Hours, Date: 25 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

- 19 Isothermal power of a compressor depends on
- A) absolute intake pressure C) free air delivered
 B) pressure ratio D) All of the above
- 20 In a transformer on load, if the secondary voltage is one-fourth the primary voltage, then the secondary current will be
- A) four times the primary current C) one-fourth the primary current
 B) equal to the primary current D) two times the primary current
- 21 The intersection point of the centrifugal pump characteristic curve and the design system curve is the
- A) pump efficiency point C) system efficiency point
 B) best efficiency point D) None of the above
- 22 Motor efficiency will be improved by
- A) reducing the slip C) reducing the diameter of the motor
 B) increasing the slip D) decreasing the length of the motor
- 23 If 30,000 kcal of heat is removed from a room every hour then the refrigeration tonnage will be nearly equal to
- A) 30 TR C) 10 TR
 B) 15 TR D) 100 TR
- 24 Which of the following flow controls in a fan system will change the system resistance curve
- A) Inlet guide vane C) speed change with hydraulic coupling
 B) speed change with variable frequency drive D) discharge damper
- 25 Demand Side Management helps
- A) to reduce the energy losses C) to promote energy efficiency among users
 B) to reduce system peak demand D) All of the above
- 26 The illuminance is 20 Lux from a lamp at 2 meter distance. The illuminance at half the distance will be
- A) 5 Lux C) 40 Lux
 B) 10 Lux D) 80 Lux
- 27 The T2, T5, T8 and T12 fluorescent tube light are categorized based on
- A) diameter of the tube C) quality of material used
 B) length of the tube. D) None of the above.
- 28 Two most important electrical parameters, which are to be monitored on generator panel, among the following, for safe operation of a Diesel generator set are:
- A) voltage and ampere C) power factor and voltage
 B) kVA and ampere D) kW and kVA

- 29 Which loss is considered the most unreliable or complicated to measure in electric motor efficiency testing?
- A) stator Cu loss
B) rotor Cu loss
C) stator Iron loss
D) stray loss
- 30 For a 6 pole induction motor operating at 49.5 Hz, the percentage slip at a shaft speed of 950 RPM will be
- A) 0.4
B) 4.0
C) 40
D) None of the above.
- 31 The FAD of a reciprocating compressor is directly proportional to
- A) pressure
B) volume
C) speed
D) All of the above
- 32 Typical acceptable pressure drop in mains header at the farthest point of an industrial compressed air network is
- A) 0.3 bar
B) 0.5 bar
C) 0.7 bar
D) 1 bar
- 33 The hydraulic power of a motor pump set is 8 kW. If the power drawn by the motor is 16 kW at 90% efficiency, the pump efficiency will be around
- A) 50 %
B) 55 %
C) 90%
D) None of the above
- 34 The purpose of inter-cooling in a multistage compressor is to
- A) Increase the pressure of air
B) Separate moisture and oil vapour
C) Reduce the work of compression
D) None of the above
- 35 The most energy intensive heat transfer loop of a vapour compression refrigeration system is
- A) Condenser water loop
B) Chilled water loop
C) Refrigerant loop
D) Indoor air loop
- 36 The power measured in a boiler ID fan is 52 kW operating at 49 Hz. As an energy conservation measure the Variable Frequency Drive (VFD) was installed and the fan was operated at 34 Hz. The estimated power savings will be around
- A) 8.6 kW
B) 17.2 kW
C) 34.7 kW
D) None of the above.
- 37 Which of the following component has maximum effect on cooling tower performance?
- A) fill media
B) drift
C) louvers
D) casing
- 38 Which of the following is not used for speed control
- A) Variable Frequency drive
B) Soft starter
C) Hydraulic coupling
D) Eddy current drives
- 39 In electrical distribution system, commercial loss covers discrepancies due to
- A) Meter Reading
B) Metering
C) Collection Efficiency
D) All of the above

Section B: Short Question

- | | Marks |
|---|-------|
| 01 A pump is delivering $40 \text{ m}^3/\text{hr}$ of water with a discharge pressure of 29m. The water is drawn from a sump where water level is 6m below the pump centerline. The power drawn by the motor is 7.5 kW at 89% motor efficiency. Find out the pump efficiency. | 5 |
| 02 Discuss in brief any three methods by which energy can be saved in a building air conditioning system. | 5 |
| 03 In an energy audit, it was observed that the fan was delivering $18,500 \text{ Nm}^3/\text{hr}$ of air with static pressure rise of 52 mm WC. The power measurement of the 3-phase induction motor coupled with the fan recorded 3.1 kW/ phase on an average. The motor operating efficiency was assessed as 88% from the motor performance curves. What would be the fan static efficiency? | 5 |
| 04 In an engineering industry, while conducting a leakage test in the compressed air system, following data for a reciprocating air compressor was recorded:

Compressor capacity = 50 m^3 per minute
Average load time = 120 seconds
Average unload time = 240 seconds

Find out the leakage quantity in m^3 per day (assume 20 hours per day of operation) | 5 |
| 05 An induced draft-cooling tower is designed for a range of 7°C . An energy manager finds the operating range as 4°C . In your opinion what could be the reasons for this type of situation. | 5 |
| 06 A 180 kVA, 0.80 PF rated DG set has diesel engine rating of 220 BHP. What is the maximum power factor which can be maintained at full load on the alternator without overloading the DG set? (Assume alternator losses and exciter power requirement as 5.60 kW and there is no derating of DG set) | 5 |
| 07 The COP of a vapour compression refrigeration system is 3.0. If the compressor motor draws power of 8.5 kW at 89% motor efficiency, find out the tonnage of the refrigeration system. | 5 |
| 08 List any five industrial applications of a heat pump. | 5 |

Section C: Long Question

- | | | Marks |
|----|---|-------|
| 01 | A cooling tower cools 1350 m ³ /hr of water from 43°C to 36.6°C at 30°C wet bulb temperature. The cooling tower fan flow air rate is 9,50,000 m ³ /hr (air density =1.08 kg/m ³) and operates at 2.7 cycles of concentration.

Find out the following
i) Range
ii) Approach
iii) % CT Effectiveness
iv) L/G Ratio in kg/kg
v) Cooling Duty Handled in TR
vi) Evaporation Losses in m ³ /hr
vii) Blow down requirement in m ³ /hr
viii) Make up water requirement in m ³ /hr | 10 |
| 02 | A plant has 2 identical 500 kVA transformers, each with a no-load loss of 0.80kW and full load copper loss of 5.7 kW. The plant average load is 420 kVA and has never exceeded 460 kVA in the past. An energy auditor while conducting the energy audit found that only single transformer is kept in operation and second transformer is switched off. The plant management was of the view that since the plant load is well within the reach of one transformer, therefore there is no need of keeping the second transformer in parallel operation. As claimed by the management, plant would be saving no load loss of transformer, which is 0.80kW.

a) In your opinion, whether energy auditor would agree with the stand taken by the management.
b) If not, what he would like to advise the plant management on transformers operation keeping in view the energy saving potential, reliability and safety of the system | 10 |
| 03 | List any 10 Energy Conservation measures in compressed air system. | 10 |
| 04 | A 10 TPH Boiler was operating at 50% loading with 60% damper opening of ID Fan. The following two proposals were considered for implementation.

Proposal -1: Incorporate VSD (efficiency of VSD 95%)
Investment = BDT. 2.5 lakhs

Proposal-2 : Change the fan pulley SIZE
Investment = BDT. 20,000

Motor input is 18 KW at full load
Motor and transmission efficiency = 92%
Cost of Power = BDT 4.00/unit
Annual operating hours= 6000
Assume fan efficiency is not changed

If speed of the fan is reduced to 75% of rated speed, as an energy manager which option will you select for better pay back period? | 10 |

- 05 An energy audit was conducted to find out the ton of refrigeration (TR) of an Air Handling Unit (AHU). The audit observations are as follows. 10

Parameter	Values
Evaporator area (m ²)	10.0
Inlet velocity (m/s)	1.9
Inlet air DBT (°C)	21.5
RH (%)	75.0
Enthalpy (kJ/kg)	53.0
Outlet air DBT (°C)	17.4
RH (%)	90.0
Enthalpy (kJ/kg)	46.4
Density of air (kg/m ³)	1.14

Find out the TR of AHU.

- 06 The useful full load torque of a 3 phase, 6 pole, 50 Hz induction motor is 162.84 *N-m*. The rotor *e.m.f.* is observed to make 90 cycles per minute. Calculate (a) motor output (b) Cu Loss in rotor (c) motor input and (d) efficiency if mechanical torque lost in windage and friction is 20.36 *N-m* and stator losses are 830 W. 10