Invigilator's Signature Sustainable and Renewable Energy Development Authority (SREDA) Power Division, Ministry of Power, Energy and Mineral Resources 4th Energy Auditor Certification Examination-2023 Paper- 3 5 Candidate's Roll No. 2 2 3 0 0 Examinee's Name ____ چ <u>}</u> 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	В	C	D	18	A	В	C	D	35	A	В	C	D
2	A	В	C	D	19	A	В	C	D	36	A	В	C	D
3	A	В	C	D	20	A	В	C	D	37	A	В	©	D
4	A	В	С	D	21	A	В	C	D	38	A	В	C	D
5	A	В	C	D	22	A	В	C	D	39	A	В	C	D
6	A	В	C	D	23	A	В	C	D	40	A	В	C	D
7	A	В	C	D	24	A	В	C	D	41	A	В	C	D
8	A	В	С	D	25	A	В	С	D	42	A	В	C	D
9	A	В	C	D	26	A	В	C	D	43	A	В	C	D
10	A	В	С	D	27	A	В	С	D	44	A	В	C	D
11	A	В	C	D	28	A	В	C	D	45	A	В	C	D
12	A	В	C	D	29	A	В	C	D	46	A	В	C	D
13	A	В	C	D	30	A	В	C	D	47	A	В	©	D
14	A	В	C	D	31	A	В	C	D	48	A	В	C	D
15	A	В	C	D	32	A	В	C	D	49	A	В	C	D
16	A	В	С	D	33	A	В	С	D	50	A	В	C	D
17	A	В	С	D	34	A	В	С	D					

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

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Section A

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

 $1 \ge 50 = 50$

1	If the efficiencies of a power plant, transmission and distribution systems are 30%, 95% & 85% respectively, the cascade efficiency of transmission and distribution system is given by						
	A) 24.23%	C) 95%					
	B) 80.75%	D) 85 %.					
2	Coefficient of Performance (COP) for a refrigeration compressor is given by						
	A) power input to compressor (kW) / cooling effect (kW)	C) Q x C _P x $(T_i - T_o) / 3024$					
	B) cooling effect (kW) / Power input to compressor (kW)	D) None of the above					
3	A pump with 200 mm impeller is delivering a flow of 120 m ³ /hr. If the flow is to be reduced to 100 m ³ /hr by trimming the impeller, what should be the impeller size? A) 167 mm C) 60 mm						
	B) 240 mm	D) None of the above					
4	The common type of compressed air-drying	g system adopted in industry is					
	A) Adsorption dryer	C) Thermic fluid oil type dryer					
	B) Steam dryer	D) All of the above.					
5	Which is not a positive displacement compressor						
	A) Reciprocating	C) Roots Blower					
	B) Rotary	D) Axial					
6	The COP of a vapour compression refrigeration system is 3.0. If the power input to compressor is 100 kW, the tonnage of refrigeration system is given by A) 85.3 C) 300						
	B) 9.48	D) None of the above					
7 The largest potential for electricity savings with variable speed drives is ger							
	A) variable torque applications	C) conveyor belt applications					
	B) constant torque applications	D) balance torque applications					
8	Harmonics are generated by						
	A) variable frequency drive	C) eddy current drive					
	B) fluid coupling	D) energy efficient motor					
9	The efficiency of a pump does not depend on						
	A) suction head	C) density of fluid					
	B) discharge head	D) motor efficiency					

10	In the city electrical distribution scheme, a proposal is being prepared to upgrade 33 kV network to 66 kV. The distribution loss, corresponding to the same quantum of load in the proposed upgraded system will be $\frac{1}{250} = \frac{1}{250} = \frac{250}{100}$					
	A) less by 25%	C) less by 75%				
	B) less by 33%	D) None of the above				
11	The fan characteristic curve is a plot of					
	A) static pressure vs flow	C) total pressure vs flow				
	B) dynamic pressure vs flow	D) suction pressure vs flow				
12	In which of the following fans air enters and leaves the fan with no change in direction					
	A) forward curved	C) radial				
	B) backward curved	D) propeller				
13	In a fluid coupling, connecting an induction	motor and a fan				
	A) motor speed can be changed by the fluid coupling	C) both motor and fan speed can be changed by the fluid coupling				
	B) fan speed can be changed by the fluid coupling	D) None of the above is possible				
14	Friction loss in a piping system carrying flu	id is proportional to				
	A) fluid flow	C) 1/fluid flow				
	B) (fluid flow) ²	D) $1/(\text{fluid flow})^2$				
15	A process fluid at 40 m ³ /hr, with a density of 0.95 is flowing in a heat exchanger and is to be cooled from 35°C to 29°C. The fluid specific heat is 0.78 kCal/kg. If the chilled water range across the heat exchanger is 4°C, the chilled water flow rate is					
	A) 44.46 m ³ /hr	C) 35 m ³ /hr				
	B) 40 m ³ /hr	D) None of the above				
16	The order of movement of thermal energy in HVAC system is					
	A) Indoor air - Chilled water - Refrigerant- Condenser water- Cooling tower	C) Indoor air - Condenser water - Chilled water - Cooling tower - Refrigerant				
	B) Chilled water - Indoor air - Refrigerant- Cooling tower - Condenser water	D) Indoor air - Chilled water – Refrigerant - Cooling tower - Condenser water				
17	The slip of a synchronous motor will be					
	A) more than the induction motor	C) zero				
	B) less than the induction motor	D) load dependent				
18	The efficiencies of a power plant and	transmission systems are 40%, and				
	97% respectively. The percentage loss of	the distribution system of the same				
	network is 23%. The cascade efficiency	of generation, transmission and				
	distribution system is given by					
	A) 8.92 %	C) 40 %				

B) 29.87%	D) 23%
/	/

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 pur	np 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 roo	om 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 faresistance curve	an system will change the system			
	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 distance will be	meter distance. The illuminance at half the			
	A) 5 Lux	C) 40 Lux			
	B) 10 Lux	D) 80 Lux			
27	The T2, T5, T8 and T12 fluorescent tube lig	ght 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	h are to be monitored on generator panel, among			
-	the following, for safe operation of a Diesel gen	herator 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	C) stator Iron loss			
	B) rotor Cu loss	D) stray loss			
30	For a 6 pole induction motor operating at 49 of 950 RPM will be	9.5 Hz, the percentage slip at a shaft speed			
	A) 0.4	C) 40			
	B) 4.0	D) None of the above.			
31	The FAD of a reciprocating compressor is c A) pressure	lirectly proportional to C) speed			
	B) volume	D) All of the above			
32	Typical acceptable pressure drop in mains compressed air network is A) 0.3 bar	header at the farthest point of an industrial			
	$\mathbf{B}(0.5 \text{ bar})$	D) 1 har			
33	The hydraulic power of a motor pump set is	x = 8 kW If the power drawn by the motor is			
55	16 kW at 90% efficiency, the pump efficien	cy will be around			
	A) 50 %	C) 90%			
	B) 55 %	D) None of the above			
34	The purpose of inter-cooling in a multistage	e compressor is to			
	A) Increase the pressure of air	C) Reduce the work of compression			
	B) Separate moisture and oil vapour	D) None of the above			
35	The most energy intensive heat transfer loop of A) Condenser water loop	a vapour compression refrigeration system is C) Refrigerant loop			
	B) Chilled water loop	D) Indoor air loop			
36	5 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	C) 34.7 kW			
	B) 17.2 kW	D) None of the above.			
37	Which of the following component has maximum and the full of the following component has maximum and the full of the following component has maximum and the following	imum effect on cooling tower performance?			
	A) fill media	C) louvers			
	B) drift	D) casing			
38	Which of the following is not used for speed coA) Variable Frequency drive	ntrol C) Hydraulic coupling			
	B) Soft starter	D) Eddy current drives			
39	In electrical distribution system, commercial los A) Meter Reading	ss covers discrepancies due to C) Collection Efficiency			
	B) Metering	D) All of the above			

40	The isothermal power of 500 CFM air compressor is 72 kW and the efficiency is 76 %. The				
	actual power drawn by the compressor will be around				
	A) 56 %	C) 89%			
	B) 72 %	D) 95 %			
41	The percentage reduction in distribution losses when tail end power factor is raised from 0.8 to 0.95 is				
	A) 15.5 %	C) 39.4 %			
	B) 29.4 %	D) None of the above			
42	Which among the following is one of the p Compressors?	parameters used to classify fans, blowers &			
	A) Mass flow rate	C) Volume flow rate			
	B) Specific ratio	D) Volume delivered			
43	Which one is a measure of effect of light on A) Efficacy	the perceived colour of objects C) CRI			
	B) CCT	D) Lumen			
44	The iron losses in a transformer are proportiona	l to			
	A) kVA load	C) cube of kVA			
	B) square of kVA load	D) None of the above			
45	The efficiency of compressed air system is a	around			
	A) 10 %	C) 40 %			
	B) 25 %	D) 90 %			
46	6 A centrifugal pump is delivering 200 m ³ /hr. The impeller diameter is trimmed by 10%. The new flo (m ³ /hr) will be				
	A) 162	C) 200			
	B) 180	D) 222			
47	The refrigerant used in vapour absorption sy	ystems is			
	A) freon	C) pure water			
	B) steam	D) lithium bromide			
48	Higher the COC in a cooling tower, the blow do A) increase	own quantity will C) decrease			
	B) no change	D) it may increase or decrease			
49	Heat Rate of a thermal power plant is expressed A) kWh/kCal	in C) kWh/kJ			
	B) kCal/kWh	D) kCal/kVAh			
50	output				
·	A) roots blower	C) reciprocating compressor			
	B) screw compressor	D) None of the above			

Section B: Short Question

- ⁰¹ A pump is delivering 40 m³/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.
- 02 Discuss in brief any three methods by which energy can be saved in a building air conditioning system.
- O3 In an energy audit, it was observed that the fan was delivering 18,500 5 Nm³/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?
- 04 In an engineering industry, while conducting a leakage test in the 5 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 m³ per day (assume 20 hours per day of operation)

- An induced draft-cooling tower is designed for a range of 7°C. An energy 5 manager finds the operating range as 4°C. In your opinion what could be the reasons for this type of situation.
- 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)
- 07 The COP of a vapour compression refrigeration system is 3.0. If the 5 compressor motor draws power of 8.5 kW at 89% motor efficiency, find out the tonnage of the refrigeration system.
- 08 List any five industrial applications of a heat pump.

Marks 5

5

5

P3 A (Page 8 of 10)

Section C: Long Question

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 m³/hr (air density =1.08 kg/m³) and operates at 2.7 cycles of concentration. Marks 10

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 m³/hr
- vii) Blow down requirement in m³/hr
- viii) Make up water requirement in m³/hr
- 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
- 03 List any 10 Energy Conservation measures in compressed air system.
- 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

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

O5 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.

Find out the TR of AHU.

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