Sustainable and Renewable Energy Development Authority (SREDA)

Power Division, Ministry of Power, Energy and Mineral Resources

3rd Energy Auditor Certification Examination-2022

Paper- 4

Candidate's Roll | 2 | 0 | 2 | 2 | 1 | 1 | | | |

Invigilator's Signature

Examinee's Name _____

B

Paper 4: Energy Performance Assessment for Equipment & Utility Systems

Total Marks- 100, Time- 3.00 Hours, Date: 28 November 2022

Invigilator's Signature

- **Important Instruction:**

1. This Paper has 20 MCQs + 4 Short Questions + 6 Long Questions = 30 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	Ⓐ	Ⓑ	Ⓒ	Ⓓ	8	Ⓐ	Ⓑ	Ⓒ	Ⓓ	15	Ⓐ	Ⓑ	Ⓒ	Ⓓ
2	Ⓐ	Ⓑ	Ⓒ	Ⓓ	9	Ⓐ	Ⓑ	Ⓒ	Ⓓ	16	Ⓐ	Ⓑ	Ⓒ	Ⓓ
3	Ⓐ	Ⓑ	Ⓒ	Ⓓ	10	Ⓐ	Ⓑ	Ⓒ	Ⓓ	17	Ⓐ	Ⓑ	Ⓒ	Ⓓ
4	Ⓐ	Ⓑ	Ⓒ	Ⓓ	11	Ⓐ	Ⓑ	Ⓒ	Ⓓ	18	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5	Ⓐ	Ⓑ	Ⓒ	Ⓓ	12	Ⓐ	Ⓑ	Ⓒ	Ⓓ	19	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6	Ⓐ	Ⓑ	Ⓒ	Ⓓ	13	Ⓐ	Ⓑ	Ⓒ	Ⓓ	20	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7	Ⓐ	Ⓑ	Ⓒ	Ⓓ	14	Ⓐ	Ⓑ	Ⓒ	Ⓓ					

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

Do not write or mark anything on this page

Section A: MCQ

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

1 x 20 =20

1 If the compressor of 200 cfm loads in 10 seconds and unloads in 20 seconds, the air leakage would be

A) 67 cfm
C) 100 cfm
B) 10 cfm
D) 133 cfm

2 Reduction of 1 bar in the delivery pressure of a Compressor working at 7 bar, would reduce the power consumption by

A) 2 – 3 %
C) 12 – 14 %
B) 6 - 10 %
D) None of the above

3 The average rated life of CFL is___

A) 5,000 hours
C) 7,000 hours
B) 10,000 hours
D) 1,000 hours

4 The ratio of luminous flux emitted by a lamp to the power consumed by the lamp is ___.

A) Illuminance
C) Luminous Efficacy
B) Lux
D) CRI

5 Axial fans are best suitable for____ application.

A) Large flow, low head
C) High head, large flow
B) Low flow, high head
D) Low flow, low head

6 The outer tube of the pitot tube is used to measure _____

A) Static pressure
C) Total pressure
B) velocity pressure
D) Dynamic pressure

7 What determines the thermal loading on the motor?

A) Duty/Load cycle
C) Age of the motor
B) Temperature of the winding
D) Ambient conditions

8 Constant torque variable frequency drives would be more appropriate for-

A) Centrifugal fan
C) Centrifugal pump
B) Reciprocating pump
D) All of the above

9 The essential parameter to estimate cooling load from air side across air handling unit (AHU) / Fan Coil Unit (FCU) _____.

A) Flow rate
C) Wet bulb temperature
B) Dry bulb temperature
D) All of the above

10 Which cooling system has highest COP?

A) Water cooled vapor compression chiller
C) Air cooled vapor compression chiller
B) VRF
D) Vapor absorption chiller

11 Good opportunity for energy savings from continuous blow down water of boiler is by ___.

A) reusing the hot water so formed as make up water

B) using the blow down steam to run steam turbine

C) utilization of flash steam in deaerator

D) none of the above

12 De-aeration of boiler feed water is referred to as

A) removal of dissolved gases

B) removal of silica

C) removal of scales by blow down

D) phosphate treatment of feed water

13 In a combined cycle power plant consisting of gas turbine and waste heat boiler, the exhaust gas temperature is ____.

A) around 150 °C

B) around 500 °C

C) around 300 °C

D) around 400 °C

14 Cogeneration is the simultaneous generation of ----------.

A) heat and power

B) steam and condensate

C) Mechanical Energy and power

D) All of the above

15 If the speed of a centrifugal pump is doubled, its power consumption increases by---------- times.

A) two

B) four

C) eight

D) no change

16 If the delivery valve of the pump is throttled such that it delivers 30% of the rated flow, one of the best options for improved energy efficiency would be

A) Trimming of the impeller

B) Replacing the motor

C) Replacing the impeller with a smaller sized impeller

D) None of the above

17 LMTD needs correction for which heat exchanger?

A) Multi-pass shell and tube heat exchangers

B) Cross flow heat exchanger

C) None of A and B

D) Both of A and B

18 Heat transfer of a heat exchanger can be increased by increasing

A) Velocity of fluids

B) Surface area

C) Temperature difference of two fluids

D) All of the above

19 The cost of replacement of inefficient compressor with an energy efficient compressor in a plant was BDT 5 lakh. The net annual cash flow is BDT 1.25 lakh. The return on investment is

A) 15%

B) 20%

C) 25%

D) 19.35%

20 Sensitivity analysis is an assessment of _____

A) Profits

B) Losses

C) Risk

D) All of the above

Section B: Short Question

		Marks
01	A fan-duct system is designed so that when the air temperature is 20°C, the mass flow rate is 25,000 kg/hr when the fan speed is 800 rpm and the fan motor requires 8 kW. A new set of requirements is imposed on the system: the operating air temperature is changed to 50°C, and the fan speed is increased so that the same mass flow of air prevails. What are the revised fan speed and power requirements?	5

02	A proposed project for cooling tower optimisation requires an initial capital investment of Tk.20,000. The cash flow generated by the project are shown in the table below: Year — Cash flow, (Tk.) 0 — -20,000.00 1 — +8,000.00 2 — +8,000.00 3 — +8,000.00 4 — +6,000.00 5 — +6,000.00 6 — +6,000.00 Calculate the gross and net annual rate of return for the project.	5
03	A centrifugal water pump operates at 30 m^3/hr and at 1440 RPM. The pump operating efficiency is 60% and motor efficiency is 92%. The discharge pressure gauge shows 3.4 kg/cm^2. The suction is 3 m below the pump centerline. If the speed of the pump is reduced by 25%, estimate the following: a. pump flow, b. pump head and c. motor power.	5

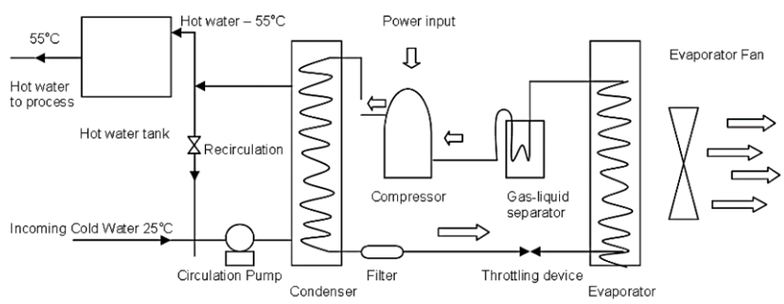
04	A company borrows BDT 5,00,00,00 to finance a new boiler installation. If the interest rate is 12% per annum and the repayment period is 5 years. Calculate the value of the total repayment and the monthly repayment value, assuming (i) simple interest and (ii) compound interest.	5

Section C: Long Question

		Marks
01	a) In a 100 kW four pole induction motor operating at 50 Hz and rated for 415 V and 1440 RPM, the actual measured speed is 1470 RPM. Find out the percentage loading of the motor if the voltage applied is 428 V. b) A 6 pole, 415 volt, 3 ø, 50 Hz induction motor delivers 10 kW power at rotor shaft at a speed of 950 rpm with PF of 0.90. The total loss in the stator including core, copper and other losses is 1 kW. Calculate the followings: i) Slip ii) Rotor Copper Loss iii) Total Input to motor iv) Line current at 415 V and motor PF of 0.88 v) Motor operating efficiency	10

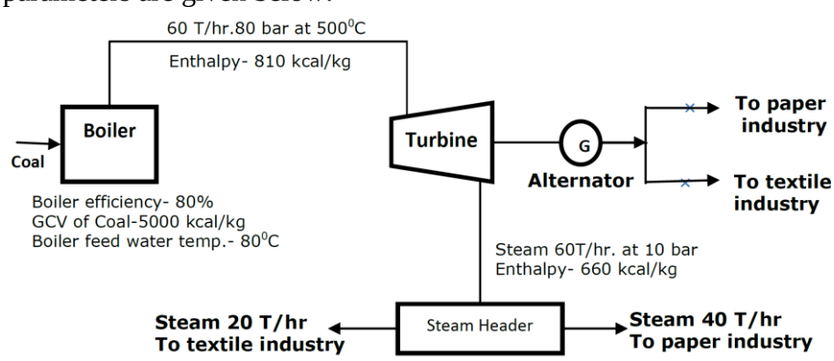
02	A pharmaceutical unit had installed a centralized refrigeration system of 100 TR Capacity several years ago. The refrigeration system operates 24 hours a day, 200 days per annum and the average electricity cost is BDT 7.5/ kWh. The following are the key operational parameters. Compressor operating current and power factor: 153 amps. 0.95 pf Condenser pump operating current and power factor: 43 amps, 0.9 pf Chiller pump operating current and power factor: 25 amps, 0.95 pf CT fan operating current and power factor : 20 amps. 0.75 pf ΔT across the chiller (evaporator) : 3.5^{o}C Chilled water flow : 23 Lit / Sec Total head developed by chiller pump : 30 m. Condenser water flow : 30 Lit / Sec Total head developed by condenser pump : 27 mtrs. **PS:** all the motors operate at 415 Volts and efficiency of 90%	10

03	A shell-and-tube heat exchanger with 2-shell passes and 8-tube passes is used to heat ethyl alcohol (C_p = 2670 J/kg·^{o}C) in the tubes from 25^{o}C to 75^{o}C at a rate of 2.0 kg/s. The heating is to be done by water (C_p= 4190 J/kg·^{o}C) that enters the shell side at 95^{o}C and leaves at 45^{o}C. The LMTD correction factor for this heat exchanger is 0.82. If the overall heat transfer coefficient is 1000 W/m^2·^{o}C, determine the flow rate of water in kg/s and surface area of the heat exchanger in m^2.	10

04	In a food processing unit, 24,000 litres of water per day is to be heated from 25°C to 55°C. Presently this requirement is met by an electrical heater. The management is planning to install a vapor compression heat pump system having a COP of 2.3 which includes the compressor motor losses. The schematic of the heat pump hot water system is given below:  Schematic of Heat Pump Hours of operation of water circulation pump = 24 hours/day Evaporator fan operation = 20 hours/day Energy consumption of water circulation pump and evaporator fan per day = 50 kWh Compressor motor efficiency = 88 % Annual operating days of heat pump = 330 days Cost of electrical energy = Tk.10/kWh Heat loss in the condenser and hot water tank in addition to the heat load = 5% Investment for heat pump = Tk. 15 Lakhs The compressor and evaporator fan are interlocked in operation. Find out i) Heat pump capacity in TR in terms of heat delivered	10

	ii) The payback period of investment towards heat pump iii) Evaporator capacity in TR	

05	Estimate the boiler efficiency by indirect method for the following data. Type of fuel fired = Paddy Husk **Composition:** Moisture = 10.79% Mineral Matter = 16.73% Carbon = 33.95% Hydrogen = 5.01% Nitrogen = 0.91% Sulphur = 0.09% Oxygen = 32.52% GCV (kcal/kg) = 3568 Cost of Paddy Husk = Tk. 1100 / MT Ambient DBT = 32 ^{o}C Boiler parameters on Paddy Husk Flue gas temperature = 190 ^{o}C CO_2 in flue gas = 12 % The losses other than exhaust loss = 28%	10

06	A common plant facility is installed to provide steam and power to textile and paper plant with a co-generation system. The details and operating parameters are given below:  Other data: - Turbine, alternator and other losses = 8% - Specific steam consumption in paper industry = 5 Tons/Ton of paper - Specific power consumption in paper industry = 600 kWh/Ton of paper	10

	Calculate: i. Coal consumption in boiler per hour or per day. ii. Power generation from co-generation plant iii. If 10% is auxiliary power consumption in co-generation plant, how much power is consumed by the textile industry per hour? iv. What is the gross heat rate of turbine?	