Invigilator's Signature

Sustainable and Renewable Energy Development Authority (SREDA)

Power Division, Ministry of Power, Energy and Mineral Resources

3rd Energy Auditor Certification Examination-2022

Paper- 3

Candidate's Roll No. | 2 | 0 | 2 | 2 | 1 | 1 | | | |

Examinee's Name _____

A

Paper 3: Energy Efficiency in Electrical Systems

Total Marks- 150, Time- 3.00 Hours, Date: 27 November 2022

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

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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

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

1 x 50 =50

1 The percentage reduction in distribution loses when tail end power factor raised from 0.78 to 0.95 is

A) 25 %
C) 33 %
B) 29 %
D) 37 %.

2 If voltage applied to a 415 V rated capacitors drops by 5 %, its VAR output drops by

A) 5%.
C) 15 %
B) 10 %.
D) 19 %

3 In rotating electrical machines, when the armature rotates, there are continuous magnetic reversals and power required for their reversals is called

A) Ohmic losses.
C) Hysteresis loss.
B) Eddy current loss.
D) Mechanical loss

4 Which one of the following is not the effects of harmonics on distribution network?

A) Misfiring of AC and DC Drives
C) Overloading and overheating of motors
B) Reduced power factor
D) None of the above.

5 Way to improve system efficiency is

A) Maintain power factor
C) Remove load shedding
B) Identify and fix distribution system losses
D) Both of (A) and (B)

6 The voltage of a bus can be increased by adding

A) capacitor to the bus
C) parallel lines between buses
B) generator to the bus
D) All of the above

7 Which one of the following is not needed for the calculation of rotor copper loss

A) Rotor Speed
C) Shaft Power
B) Rotor current
D) All of the above

8 Low voltage problem at motor terminals can be corrected by

A) Relocating transformers
C) Tap changing at the transformers
B) Increasing cable size
D) All of the above

9 The efficiency of the transformer generally is

A) Above 99%
C) Between 96% to 93%
B) Between 96% to 99%
D) Between 90% to 93%

10 The rated no load and load losses of a transformer are 2 kW and 20 kW, respectively. What should be the total losses in a transformer when it is operating at 50% loading

A) 7 kW
C) 12 kW
B) 11 kW
D) 21 kW

11 As per IEEE standard, the permissible harmonic limit for 33kV or lower bus voltage is

A) 1 %
C) 2.5 %
B) 1.5 %
D) 5%

12 What is percentage of the Stray Load Loss in motor as mentioned in IEC

A) 0.1 %
C) 1 %
B) 0.5 %
D) 2 %

13 If distribution of power is raised from 11 kV to 33 kV, the voltage drop would lower by a factor

A) 1/9 times
C) 9 times
B) 1/3 times
D) 3 times

14 Voltage imbalance is a condition in which the three-phase voltage differ in

A) Amplitude
C) Both (A) and (B)
B) Phase
D) None of (A) and (B)

15 Which of the following is not a source of harmonic current?

A) Capacitor switching
C) Resistive load
B) Inductive load
D) All of the above

16 When evaporator temperature is increased

A) power consumption increases
C) refrigeration capacity decreases
B) specific power consumption remains same
D) refrigeration capacity increases

17 Which of the following flow controls in a fan system will change the system resistance curve?

A) Inlet guide vane
C) discharge damper
B) speed change with variable frequency drive
D) speed change with hydraulic coupling

18 The distinction between fans and blowers is based on?

A) Impeller diameter
C) Speed
B) Specific ratio
D) Volume delivered

19 The CRI of a GSL is

A) Less than 60
C) Between 75 to 95
B) Between 60 to 75
D) Above 95

20 Increasing the impeller diameter in a pump

A) Increases the flow
C) Decreases the power
B) Decreases the head
D) All of the above

21 Modest flow variation between 80% to 100%, in a centrifugal fan is achieved more efficiently with

A) Inlet damper
C) Inlet guide vanes
B) Outlet damper
D) Impeller Change

22 A 3000 MW super thermal power station generated 19710 million units in the year 2021-22. Its Plant Load Factor (PLF) is

A) 55%
C) 75%
B) 65%
D) 85%

23 It is possible to run pumps in parallel if their _____ are similar.

A) Suction heads
C) Closed valve heads
B) Discharge heads
D) None of the above

24 The motor efficiency is 0.9 and the pump efficiency is 0.6.The input power to the motor driving the pump is 28 kW. The power transmitted to the water is

A) 15.12 kW
C) 19.23 kW
B) 17.25 kW
D) None of the above

25 In a DG set, a 3 phase alternator is supplying on an average 100 A at 420 V and 0.9 pf to a load. If the specific fuel consumption of this DG set is 0.30 liters/ kWh at that load, then how much fuel is consumed while delivering generated power for one hour?

A) 11.55 liter
C) 19.65 liter
B) 15.35 liter
D) 23.85 liter

26 In an induction motor the loss which is independent of motor load is

A) Rotor copper loss
C) Friction and windage loss
B) Stator copper loss
D) All of the above

27 Which one of the following lamp has the greater life?

A) CFL
C) Induction lamps
B) Incandescent lamps
D) Fluorescent lamps

28 For the same quantity of power handled

A) Lower the voltage, higher the current
C) Higher the voltage, higher both current and power-factor
B) Lower the voltage, lower the current
D) Higher the voltage, higher the current and lower the power factor

29 In an electrical system, higher the PF is

A) Higher the voltage drop
C) System performance decreases
B) Lower the voltage drop
D) System performance increases

30 Devices that draw non-sinusoidal current when a sinusoidal voltage supplied create

A) harmonics
C) melody
B) light
D) None of the above

31 Customer is responsible for maintaining current distortion within acceptable levels, while utility is responsible for limiting

A) Power distortion
C) VAR distortion
B) Voltage distortion
D) VA distortion

32 In system management, preventive maintenance is

A) Equal to regular maintenance
C) Worked like a special maintenance
B) Not good compared to regular maintenance
D) Better than regular maintenance

33 The "Phantom Component" that vectorally combines with real power to determine kVA on the electric system is

A) kWh
C) kW
B) kVA
D) kVAR

34 The ratio of the maximum demand to the connected load is

A) Demand factor
C) Peak demand
B) Load factor
D) Peak load

35 The summation of nameplate ratings of the electrical equipment installed in consumer premise is

A) Peak demand
C) Connected load
B) Peak load
D) Load

36 A set of techniques for control of power supply and demand to increase the system load factor is known as

A) Load management
C) Demand factor
B) Load factor
D) Demand management

37 Core losses of a motor are due to

A) Hysteresis and eddy current effect
C) Low loss grade of silicon lamination
B) Thinner lamination
D) None of the above

38 Inadequate maintenance of motors can significantly

A) Increases losses and unreliability
C) Decreases losses but increase unreliability
B) Increases losses but decrease reliability
D) None of the above

39 The primary task of a cooling tower is

A) to accept heat from the atmosphere
C) both (A) & (B)
B) to reject heat to the atmosphere.
D) none of the above

40 Light is usually described as the type of electromagnetic radiation that has a wavelength visible to human eye, roughly

A) 400-700 nm
C) 7000 - 10000 nm
B) 100 - 400 nm
D) none of the above

41 The luminous flux describes the quantity of light emitted by a light source. It measures the lamp's

A) Financial efficiency
C) Both (A) & (B)
B) Economic efficiency
D) None of the above

42 For an incandescent lamp, the portion of the visible radiation is

A) 70%
C) 10%
B) 20%
D) None of the above

43 Which of the following lamps has no UV or IR radiation

A) indication lamp
C) incandescent lamp
B) LED lamp
D) halogen lamp

44 The 4 stroke operations in a diesel engine are

A) Compression - ignition - induction - exhaust
C) Induction - compression - ignition - exhaust
B) Ignition - induction - compression - exhaust
D) None of the above

45 For a captive gen set, the maximum unbalanced load between phases should not exceed the capacity of the generating sets is

A) 5%
C) 15%
B) 10%
D) 20%

46 Nos. of independent earths required for a gen set as per the electricity rules are

A) 4
C) 2
B) 3
D) None

47 For a 500 kW natural gas generator, thermal energy that can be recovered from the reciprocating engine is

A) 44%
C) 64%
B) 54%
D) 34%

48 In order to optimize the fuel utilization more, trigeneration systems are developed which involves the simultaneous production of

A) electricity, heat and cooling
C) heat, fume and cooling
B) electricity, fume and heat
D) cooling, fume and electricity

49 In a compressor, every 4^{0}C rise in inlet air temperature results in a higher energy consumption by

A) 10 %
C) 1%
B) 5%
D) None of the above

50 The CRI of LED lamp is

A) 67
C) 80
B) 77
D) 90

Section B: Short Question

		Marks
01	List five energy saving measures in a commercial building?	5
02	When connected to a 230-V (rms), 50-Hz power line, a load absorbs 4 kW at a lagging power factor of 0.8. Find the value of capacitance necessary to raise the pf to 0.95.	5

03	A pump is delivering 30 m^3/hr of water with a discharge pressure of 35 metre. The water is drawn from a sump where water level is 7 metre below the pump center line. The power drawn by the motor is 7.6 kW at 85% motor efficiency. Find out the pump efficiency.	5
04	A DG set is operating at 760 kW load with 450^0C exhaust gas temperature. The DG set generates 7 kg of exhaust gas/ kWh generated. The specific heat of gas at 450^oC is 0.25 kcal/ kg^0C. A heat recovery boiler is installed after which the exhaust temperature drops to 230^0C. How much steam will be generated at 3 kg/cm^2 with enthalpy of 650.57 kcal/ kg. Assume boiler feed water temperature as 65^oC.	5

05	State any 3 options for electricity distribution loss optimization?	5
06	Briefly describe an electric power supply system with a block diagram	5

07	“ONE Unit saved in the end user is equivalent to two units generated in the power plant” - explain the statement.	5
08	What is your understandings about shedding of non- essential loads? How it works?	5

Section C: Long Question

		Marks
01	A Residential colony having a fixed load of 250 KVA is situated 1 km away from a 3 phase, 11/0.415 kV transformer from which the power is to be fed. The management is evaluating the choice of LT (1 run x 3.5 core x 300 mm^2) vs HT (1 run x 3 core x 70 mm^2) distribution for a 1 km stretch. Given the following data, as an energy auditor what would you suggest and estimate the payback period on marginal investment (difference in the two investments). Support your recommendation with calculations. Data given: • Total Resistance of the LT cable is 0.13 Ω/km and the cost is Tk 700/m • Total Resistance of the HT cable is 0.13 Ω/km and the cost is Tk 1300/ m • Unit price is Tk 7/unit • Cost of relocating the transformer (in case of HT cabling) = Tk 1 lakh • Add voltage regulations loss (single run x √3).	10

02	The core loss and copper loss of a 6.35/0.23 kV single phase transformer are 50W and 125 W respectively at 6.5 kW load. If the load is doubled what will be the efficiency of the transformer?	10

03	a) The efficiency at various stages from power plant to end-use is given below. Efficiency of power generation in the power plant = 30 % T & D losses = 23 % Distribution loss of the plant = 6 %. Equipment end use efficiency = 65 %. What is the overall cascade system efficiency from generation to end-use? b) The energy audit observations at a cooling tower (CT) in a process industry are given below: Cooling Water (CW) Flow : 3000 m^3/hr CW in Temperature: 41^0C CW Out Temperature: 31^0C Wet Bulb Temperature: 24 ^{0}C Find out Range, Approach, Effectiveness and cooling tower capacity in kcal per hour of the CT?	10

04	Write short notes on the followings (i) Effect of supply voltage on capacitor KVAR rating (ii) Pump impeller trimming (iii) Affinity laws for centrifugal machines (iv) Trigeneration (v) Building fenestration	10

05	Describe step-by-step approach for maximum demand control?	10

06	A motor has the following specifications: Rated Power - 34 kW/45 HP, Voltage - 415 V, Current - 57 Amps, Speed - 1475 rpm, Insulation class - F, Frame - LD 200L, Connection - Delta. The no load test data of the motor are: Voltage- 415 V, Current -13.1 Amps, Frequency- 50 Hz, Stator phase resistance at 30^0C is 0.264 Ohms and no load power 1063.74 W. Calculate a) Iron plus friction and windage losses b) Stator resistance at 120^0C c) Stator copper losses at operating temperature of resistance at 120^0C d) Full load slip (s) and rotor input assuming rotor losses are slip times rotor input. e) Motor input assuming that stray losses are 0.5% of the motor rated power f) motor full load efficiency and full load power factor	10