

**NATIONAL CERTIFICATION EXAMINATION 2004
FOR
ENERGY AUDITORS**

PAPER – EA3: Energy Efficiency in Electrical Utilities

Date: 23.05.2004 Timings: 0930-1230 HRS Duration: 3 HRS Max. Marks: 150

General instructions:

- Please check that this question paper contains **7** printed pages
- Please check that this question paper contains **65** questions
- The question paper is divided into three sections
- All questions in all three sections are compulsory
- All parts of a question should be answered at one place

Section – I: OBJECTIVE TYPE

Marks: 50 x 1 = 50

- (i) Answer all **50** questions
- (ii) Each question carries **one** mark
- (iii) Put a (✓) tick mark in the appropriate box in the answer book

1.	If the voltage level of the electricity distribution system is raised from 11 kV to 33 kV for the same loading conditions, the distribution losses are reduced by a factor of a) 1/9 b) 1/3 c) 1/6 d) none of the above
2.	In electricity distribution, if the voltage is raised from 11 kV to 33 kV for the same loading conditions, the voltage drop in the distribution system would be lower by a factor of a) 1/4 b) 1/2 c) 1/3 d) none of the above
3.	If the reactive power drawn by a particular load is zero, it means the load is operating at a) lagging power factor b) leading power factor c) unity power factor d) none of the above
4.	Select the location of installing capacitor bank, which will reduce the electricity distribution losses to the maximum extent a) main sub-station bus bars b) motor terminals c) motor control centre d) distribution board bus bars
5.	A pure inductive load draws a) leading reactive power b) active power c) lagging reactive power d) none of the above

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6.	<p>The nearest kVAR compensation required for improving the power factor of a 100 kW load from 0.8 lag to unity power factor is</p> <p>a) 50 kVAR b) 75 kVAR c) 100 kVAR d) none of the above</p>
7.	<p>The percentage increase in power consumption of a compressor with suction side air filter pressure drop of 250 mmWC is closest to</p> <p>a) 0.5% b) 2% c) 3% d) 4%</p>
8.	<p>A power factor capacitor designed for 10 kVAR at 415 V was found to be operating at 400 V. The effective capacity of the capacitor would be</p> <p>a) 9.3 kVAR b) 10 kVAR c) 10.8 kVAR d) none of the above</p>
9.	<p>A four pole induction motor operating at 50 Hz, with 1% slip will run at an actual speed of</p> <p>a) 1500 RPM b) 1515 RPM c) 1485 RPM d) none of the above</p>
10.	<p>With decrease in design speed of induction motors the required capacitive kVAR for reactive power compensation for the same capacity range will</p> <p>a) increase b) decrease c) not change d) none of the above</p>
11.	<p>kW rating indicated on the name plate of an induction motor indicates</p> <p>a) rated input of the motor b) rated output of the motor c) maximum input power which the motor can draw d) maximum instantaneous input power of the motor</p>
12.	<p>For every 4°C reduction in the air inlet temperature of an air compressor, the power consumption will normally decrease by..... percentage points for the same output.</p> <p>a) 1 b) 2 c) 3 d) 4</p>
13.	<p>The acceptable pressure drop in mains header at the farthest point of an industrial compressed air network is</p> <p>a) 0.3 bar b) 0.5 bar c) 1.0 bar d) 2 bar</p>
14.	<p>PF capacitor installed at the motor starter location will improve</p> <p>a) motor design power factor b) motor operating power factor from the starter to the power supply side c) motor operating power factor from the starter to the motor terminals side d) all of the above.</p>
15.	<p>A 200 cfm compressor has a loading and unloading period of 10 seconds and 20 seconds respectively during a compressed air leakage test. The air leakage in the compressed air system would be</p> <p>a) 20.3 cfm b) 42.1 cfm c) 66.6 cfm d) 132.8 cfm</p>
16.	<p>Higher chiller COP can be achieved with</p> <p>a) lower evaporator temperature and higher condensing temperature b) lower evaporator temperature and lower condensing temperature c) higher evaporator temperature and higher condensing temperature d) none of the above</p>

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17.	Vertical type reciprocating compressors are used in the capacity range of a) 50 – 150 cfm b) 200 – 500 cfm c) 500 - 1000 cfm d) above 1000 cfm
18.	One ton of refrigeration (TR) is equal to a) 3.51 kW b) 3024 kcal/hr c) 12,000 BTU/hr d) all of the above
19.	Approximate percentage reduction in power consumption with 1 °C rise in evaporator temperature in refrigerating systems is a) 1% b) 2% c) 3% d) 4%
20.	The refrigerant used in vapour absorption systems is a) steam b) pure water c) freon d) lithium bromide
21.	Li – Br water absorption refrigeration systems have a COP in the range of a) 0.4 – 0.5 b) 0.65 – 0.70 c) 0.75 – 0.80 d) none of the above
22.	Slip ring induction motors, in general, have a design efficiency in comparison with the squirrel cage induction motors for similar ratings a) lower b) higher c) same d) none of the above
23.	System resistance in water pumping system varies with a) square of flow rate b) cube of flow rate c) square root of flow rate d) none of the above
24.	The outer tube connection of the pitot tube is used to measure in the fan system a) static pressure b) velocity pressure c) total pressure d) dynamic pressure
25.	If the speed of a pump is doubled, pump shaft power goes up by a) 2 times b) 6 times c) 8 times d) 4 times
26.	If the speed of a pump is doubled, the pump head goes up by a) 4 times b) 2 times c) 8 times d) 16 times
27.	Friction loss in a piping system carrying fluid is proportional to a) fluid flow b) (fluid flow) ² c) $\frac{1}{\text{fluid flow}}$ d) $\frac{1}{(\text{fluid flow})^2}$
28.	Shaft power of the motor driving a pump is 30 kW. The motor efficiency is 0.9 and pump efficiency is 0.6. The power transmitted to the water is a) 16.2 kW b) 18.0 kW c) 27.0 kW d) none of the above

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29.	For fans, the relation between flow discharge Q and speed N is a) $\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$ b) $\frac{Q_1}{Q_2} = \frac{N_1^2}{N_2^2}$ c) $\frac{Q_1}{Q_2} = \frac{N_1^3}{N_2^3}$ d) none of the above
30.	If inlet and outlet water temperatures of a cooling tower are 40°C and 32°C respectively and atmospheric DBT and WBT are 35 °C and 28 °C respectively then the approach of cooling tower is a) 3°C b) 4°C c) 5°C d) 7°C
31.	Cooling tower effectiveness is a) approach / (range + approach) b) range/ (range + approach) c) approach / range d) none of the above
32.	The lowest theoretical temperature to which water can be cooled in a cooling tower is a) DBT of the atmospheric air b) WBT of the atmospheric air c) average DBT and WBT of the atmospheric air d) difference between DBT and WBT of the atmospheric air
33.	Which of the following ambient conditions will evaporate maximum amount of water in a cooling tower a) 35 °C DBT and 25 °C WBT b) 40°C DBT and 38°C WBT c) 35 °C DBT and 28 °C WBT d) 38 °C DBT and 37 °C WBT
34.	In general, design chilled water temperature drop across chillers is approximately a) 5 °C b) 1 °C c) 10 °C d) 15 °C
35.	Normally a manufacturer's guaranteed best approach of a cooling tower is a) 5 °C b) 12 °C c) 8 °C d) 2.8 °C
36.	GLS lamp is a) general lighting service lamp b) general lighting source lamp c) glow light source lamp d) glow light service lamp
37.	The unit of illuminance is a) lux b) luminaire c) lumens d) none of the above
38.	Luminous efficacy of which of the following is the highest? a) CFL b) HPMV c) HPSV d) LPSV
39.	If voltage is reduced from 230 V to 200 V for a fluorescent tube light, it will result in a) reduced power consumption b) increased power consumption c) increased light levels d) no change in power consumption and light levels
40.	What is the typical frequency of a high frequency electronic ballast? a) 50 Hz b) 10 kHz c) 30 kHz d) 50 kHz

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41.	The compression ratio in diesel engines is in the range of a) 5:1 to 10:1 b) 10:1 to 13:1 c) 14:1 to 25:1 d) none of the above
42.	The rated efficiency of a diesel generator captive power plant has a range of a) 43% – 45% b) 50% – 60% c) 60% – 70% d) above 70%
43.	The maximum unbalanced load between phases should not exceed % of the capacity of the DG set a) 1 b) 5 c) 10 d) none of the above
44.	The exhaust gas waste heat recovery potential of a turbo charged genset at 500 kW loading and 480°C exhaust gas is closest to (Assume exit gas temperature of 180°C and 8 kg gas/ kWh generated) a) 1.6 lakh kCal/hr b) 2.2 lakh kCal/hr c) 3.0 lakh kCal/hr d) 3.5 lakh kCal/hr
45.	The operating efficiency of a DG set also depends on a) turbo charger performance b) inlet air temperature c) % loading d) all of the above
46.	The core losses of a transformer are the least if the core is made up of a) silicon alloyed iron (grain oriented) b) copper c) amorphous core – metallic glass alloy d) none of the above
47.	The basic functions of an electronic ballast fitted to a fluorescent tube light exclude one of the following a) to ignite the lamp b) to stabilize the gas discharge c) to supply power to the lamp at supply frequency d) to supply power to the lamp at very high frequency
48.	Modern electronic soft starters are used for motors to a) achieve variable speed b) provide smooth start and stop c) improve the loading d) none of the above
49.	The nearest kVA rating required for a DG set with 1000 kW connected load, with diversity factor of 1.5 and 84% loading and 0.8 power factor is a) 500 kVA b) 1000 kVA c) 1500 kVA d) 2000 kVA
50.	Maximum demand controller is used to a) switch off non-essential loads in a logical sequence b) switch off essential loads in a logical sequence c) controls the power factor of the plant d) all of the above.

..... End of Section – I

Section – II: SHORT DESCRIPTIVE QUESTIONS

Marks: 10 x 5 = 50

- (i) Answer all **Ten** questions
- (ii) Each question carries **Five** marks

- S-1. Calculate the transformer total losses for an average loading of 60%. Assume no load and full load losses as 3 kW and 25 kW respectively.
- S-2. (a) What is synchronous speed of an induction motor?
(b) How the % slip of an induction motor is measured?
- S-3. How does power factor of an induction motor reduce with the reduction of the applied load on the motor? Draw a curve depicting power factor vs percentage loading on the motor.
- S-4. What are the parameters required to be measured while estimating the chiller performance in kW/TR?
- S-5. A fan is operating at 900 RPM developing a flow of 3000 Nm³/hr. at a static pressure of 600 mmWC. What will be the flow and static pressure if the speed is reduced to 600 RPM.
- S-6. What are the various methods of flow control in centrifugal pumps?
- S-7. In a cooling tower, the Cycle of Concentration (C.O.C.) is 3 and evaporation losses are 1%. The circulation rate is 1200 m³ /min. Find out the blow down quantity required for maintaining the desired level of dissolved solids in the cooling water.
- S-8. Whether it is advisable to install a servo transformer for controlling the operating voltage of the lighting circuit? Justify your answer.
- S-9. A 5 MW DG set with an average load of 3 MW running in parallel with the grid was found to be exporting 100 kVAr. Without calculating, explain what could be the possible reasons for the export of reactive power to the grid. List advantages/disadvantages of the above situation.
- S-10. How are energy savings achieved through electronic ballast in a fluorescent tube light in comparison to the conventional magnetic ballast?

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Section – III: LONG DESCRIPTIVE QUESTIONS

Marks: 5 x 10 = 50

- (i) Answer all **Five** questions
- (ii) Each question carries **Ten** marks

- L-1. A plant has 2 identical 500 kVA transformers, each with a no load loss of 0.84 kW and full load copper loss of 5.7 kW. The plant average load is 300 kVA and has never exceeded 450 kVA in the past.
- (a) Compare the transformer losses when single transformer is in operation and when both transformers are in parallel operation.
 - (b) What would you like to advise to the plant's management on transformer operation keeping in view the energy saving potential, reliability and safety of the system.
- L-2. A compressed air leakage test was conducted in an engineering industry, which employs a 500 cfm reciprocating compressor. The compressed air system is maintained at the normal loading-unloading settings of 6.5 kg/cm²g and 7 kg/cm²g respectively. The following was observed for a period of 15 minutes trial:
- On load time = 40 secs
Unload time = 120 secs.
- Subsequently some of the air leakage points were attended and the leakage test was repeated. The following was observed while maintaining the same loading & unloading pressure settings and trial period:
- On load time = 20 secs
Unload time = 140 secs.
- The average power drawn during the above 2 trials was observed as 70 kW during load and 15 kW during unload condition. Calculate the annual cost savings for 5000 hr/ year of compressor operation. Assume energy charge of Rs. 5.00 per kWh.
- L-3. A centrifugal pump is delivering 30 m³/s of water at a discharge pressure of 3 kg/cm²g. The pump suction is 1 meter below the pump center line. Find out the power drawn by the motor if the pump efficiency is 60% and motor efficiency is 92%.
- L-4. Briefly explain the step by step approach for the conduct of energy audit of vapour compression refrigeration plants.
- L-5. List 10 energy saving opportunities in a cooling tower.

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