

**NATIONAL CERTIFICATION EXAMINATION 2004
FOR
ENERGY MANAGERS**

PAPER – EM3: 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.	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
2.	If the voltage level of the 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
3.	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
4.	The power factor indicated in the monthly electricity bill for industry is a) peak power factor of the day b) peak power factor achieved during the month c) average monthly power factor d) instantaneous power factor taken at the time of meter reading taken by the utility staff
5.	The vector sum of active power and reactive power is a) apparent power b) true power c) shaft 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>A four pole induction motor operating at 50 Hz, will have a synchronous speed of</p> <p>a) 1500 rpm b) 1450 rpm c) 960 rpm d) 1000 rpm</p>
8.	<p>What determines the thermal loading on the motor?</p> <p>a) duty/load cycle b) ambient temperature c) age of the motor d) none of the above</p>
9.	<p>The full load efficiency of energy efficient squirrel cage motors (in comparison with standard squirrel cage induction motors) can be generally higher by percentage points</p> <p>a) 1 b) 3 – 7 c) 8 - 10 d) 10 and 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>One low investment measure to improve efficiency of a squirrel cage induction motor, which operates consistently below 40% of its rated capacity, is by</p> <p>a) operating it in star mode b) replacing it with a correctly sized motor c) operating in delta mode d) none of the above</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) 2 b) 1 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>Dynamic air compressors are mainly of the type</p> <p>a) two stage reciprocating compressors b) centrifugal compressors c) two stage screw compressors d) none of the above</p>
15.	<p>A 100 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) 10.6 cfm b) 20.8 cfm c) 33.3 cfm d) 47.3 cfm</p>
16.	<p>Higher chiller COP can be achieved with</p> <p>a) lower evaporator temperature and higher condensing temperature b) higher evaporator temperature and lower condensing temperature c) higher evaporator temperature and higher condensing temperature d) lower evaporator temperature and lower condensing temperature</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) 3024 kcal/hr b) 3.51 kW c) 12,000 BTU/hr d) all of the above
19.	In water cooled refrigeration systems, condenser cooling water temperature should be closest to a) ambient dry bulb temperature b) ambient wet bulb temperature c) dew-point temperature d) none of the above
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.	The essential parameters to estimate cooling load from airside across air handling unit (AHU) or a fan coil unit (FCU) is a) air flow rate b) dry bulb temperature c) RH% or wet bulb temperature d) all 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.	Name the fan which is more suitable for high pressure application a) propeller type fan b) tube-axial fan c) backward curved centrifugal fan d) forward curved centrifugal fan
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.	What is the impact on flow and pressure when the impeller of a pump is trimmed? a) flow decreases and pump head increases b) both flow and pump head increases c) both pressure and flow decreases d) none of the above
28.	Shaft power of the motor driving a pump is 20 kW. The motor efficiency is 0.9 and pump efficiency is 0.6. The power transmitted to the water is a) 20.0 kW b) 18 kW c) 12 kW d) 10.8 kW

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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 WBT is 29°C then the approach of cooling tower is a) 40°C b) 32°C c) 29°C d) 3°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.	The ratio of dissolved solids in circulating water to the dissolved solids in make up water for cooling tower is termed as a) cycles of concentration b) blow down c) cooling tower effectiveness d) none of the above
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.	An ignitor is a control gear to start a a) FTL b) CFL c) Sodium vapor lamp d) none of the above
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.	Typical exit flue gas temperature of a 5 MW DG set operating above 80% load is in the range of a) 550 to 560 °C b) 210 to 240 °C c) 340 to 370 °C d) none of the above
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 approximate 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 the above.

..... End of Section – I

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Section – II: SHORT DESCRIPTIVE QUESTIONS

Marks: 10 x 5 = 50

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

- S-1. A maximum demand recorder for a plant will record the following loads over a period of 30 minutes. Compute the MD as the recorder would do
- 800 kVA for 5 minutes
 - 200 kVA for 5 minutes
 - 400 kVA for 10 minutes
 - 800 kVA for 8 minutes
 - 1500 kVA for 2 minutes
- S-2. How does the power factor of a motor reduce with the reduction in the applied load on the motor?
- S-3. Briefly explain about the importance of maintaining optimal pressure settings of a compressed air system
- S-4. Chilled water enters evaporator at 11^oC and leaves at 8^oC. The flow rate of chilled water was measured as 350 m³/hr. Calculate the tons of refrigeration capacity.
- S-5. A fan is delivering 10,000 Nm³/hr of air at static pressure rise of 60 mm WC. If the fan static efficiency is 70%, find out the shaft power of the fan.
- S-6. What do you mean by the term cavitation and describe its undesirable effects on the pumping system.
- S-7. How size of cooling tower and wet bulb temperature are related? What Cooling Tower approach value is normally used by Cooling Tower manufacturers.
- S-8. Highlight advantages of CFL (compact fluorescent lamp) over GLS lamp.
- S-9. What is the impact of unbalanced loading on DG set?
- S-10. Briefly describe the principle of variable frequency drives used along with squirrel cage induction motors.

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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. Explain the benefit of reducing maximum demand. Explain step-by-step approach in controlling the maximum demand.

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- L-2. A 10 HP, 415 V, 4 pole, 50 Hz, 3 Phase squirrel cage induction motor has a full load efficiency of 90% and power factor of 0.88. Find the following if the motor operates at full load rated values.
- current drawn by the motor
 - input power in kW
 - RPM at a full load slip of 1%
- L-3. In an engineering industry, a 500 cfm rated capacity reciprocating compressor is operated at 7 kg/cm²g to find out the system leakage loss in the plant during lunch timings when no equipment using compressed air is operated. A free air delivery test was carried out before conducting the leakage test and it was observed that, the compressor was delivering 90% of its rated capacity. The following was observed during the conduct of leakage test:
- compressor on load timing is 10 seconds and unloading pressure is 7 kg/cm²g
 - compressor power drawn during on load is 75 kW
 - compressor unload timings and loading pressure are 40 seconds and 6.5 kg/cm² g respectively.
- Find out the following:
- % air leakage in the system
 - leakage quantity in cfm.
 - power lost due to leakage
- L-4. A water pump is delivering 300 m³/hr at ambient conditions. The impeller diameter is trimmed by 10% and its speed is reduced by 10%. Find out the water flow at the changed conditions.
- L-5. (a) What is 'lux' ? State its units.
- (b) What are the advantages of high frequency electronic ballasts?

..... **End of Section – III**