

**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.	The vector sum of active power and reactive power is a) true power b) apparent power c) shaft power d) none of the above
2.	What determines the thermal loading on the motor? a) supply voltage b) duty or load cycle c) ambient temperature d) power factor
3.	A six pole induction motor operating at 50 Hz, will have a synchronous speed of a) 1500 rpm b) 1450 rpm c) 1000 rpm d) 960 rpm
4.	The nearest kVAr compensation required for improving the power factor of a 500 kW load from 0.8 lag to unity power factor is a) 500 kVAr b) 400 kVAr c) 375 kVAr d) none of the above
5.	In electricity distribution, if the voltage is raised from 3.3 kV to 6.6 kV for the same loading conditions, the distribution losses are reduced by a factor of a) 1/4 b) 1/2 c) 1/3 d) none of the above
6.	The power factor indicated in the monthly electricity bill for industry is a) peak power factor of the day b) average monthly power factor c) peak power factor achieved during the month d) instantaneous power factor taken at the time of meter reading taken by the utility staff

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18.	One ton of refrigeration (TR) is equal to a) 3024 kCal/h b) 4.51 kW c) 1,20,000 BTU/hr d) all of the above
19.	Higher chiller COP can be achieved with a) lower evaporator temperature and higher condensing temperature b) higher evaporator temperature and higher condensing temperature c) higher evaporator temperature and lower condensing temperature d) lower evaporator temperature and lower condensing temperature
20.	The refrigerant used in a vapour absorption system is a) pure water b) steam c) freon d) lithium bromide
21.	Name the fan which is more suitable for high pressure application a) backward curved centrifugal fan b) propeller type fan c) tube-axial fan d) forward curved centrifugal fan
22.	If the speed of a pump is doubled, pump shaft power goes up by a) 2 times b) 4 times c) 6 times d) 8 times
23.	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 decrease c) both flow and pump head increase d) none of the above
24.	Which type of control gives maximum benefits for fan application from energy saving point of view? a) discharge damper control b) inlet guide vane control c) variable pitch control c) speed control
25.	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
26.	For centrifugal pumps, the relation between flow discharge Q and pump 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
27.	System resistance to flow in air ducts varies with a) square root of flow rate b) square of flow rate c) cube of flow rate d) none of the above
28.	Shaft power of the motor driving a pump is 10 kW. The motor efficiency is 0.9 and pump efficiency is 0.5. The power transmitted to the water is a) 10.0 kW b) 9.0 kW c) 5.0 kW d) 4.5 kW
29.	If the speed of a pump is doubled the pump head goes up by a) 2 times b) 4 times c) 8 times d) 16 times

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30.	Normally a manufacturer's guaranteed best approach of a cooling tower is a) 2.8 °C b) 5 °C c) 8 °C d) 12 °C
31.	The ratio of dissolved solids in circulating water to the dissolved solids in make up water for cooling tower is termed as a) cooling tower effectiveness b) liquid to solid ratio c) cycles of concentration d) none of the above
32.	Which of the following ambient conditions will evaporate maximum amount of water in a cooling tower a) 40°C DBT and 38°C WBT b) 35 °C DBT and 25 °C WBT c) 38 °C DBT and 37 °C WBT d) 35 °C DBT and 28 °C WBT
33.	The lowest theoretical temperature to which water can be cooled in a cooling tower is a) DBT of the atmospheric air b) average DBT and WBT of the atmospheric air c) WBT of the atmospheric air d) difference between DBT and WBT of the atmospheric air
34.	Cooling tower effectiveness is a) range/ (range + approach) b) approach / (range + approach) c) approach / range d) range/ approach
35.	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 range of cooling tower is a) 3°C b) 8°C c) 32°C d) 40°C
36.	If voltage is increased from 200 V to 230 V for a fluorescent tube light, it will result in a) increased power consumption only b) increased light levels only c) increased power consumption and light levels d) reduced power consumption
37.	Luminous efficacy of which of the following lamps is the highest? a) LPSV b) HPSV c) HPMV d) CFL
38.	The unit of illuminance is a) lumens b) lux c) luminaire d) none of the above
39.	An ignitor is a control gear to start a a) Sodium vapor lamp b) CFL c) FTL d) none of the above
40.	The core losses of a transformer are the least if the core is made up of a) silicon alloyed iron (grain oriented) b) amorphous core – metallic glass alloy c) copper d) none of the above
41.	Centrifugal water pump impeller diameters are rarely trimmed below percent of their original size, while reducing the capacity of oversized pumps. a) 90% b) 80% c) 70% d) none of the above

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42.	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
43.	The nearest kVA rating required for a DG set with 1000 kW connected load, with diversity factor of 1.5 and 80% loading and 0.84 power factor is a) 500 kVA b) 1000 kVA c) 1500 kVA d) 2000 kVA
44.	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
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 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
47.	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
48.	Typical exit flue gas temperature of a 5 MW DG set operating above 80% load is in the range of a) 210 to 240 °C b) 340 to 370 °C c) 550 to 560 °C d) none of the above
49.	The rated efficiency of a diesel generator captive power plant has a range of a) 50% – 60% b) 43% – 45% c) 60% – 70% d) above 70%
50.	What is the typical frequency of a high frequency electronic ballast? a) 50 Hz b) 30 kHz c) 20 kHz d) 10 kHz

..... 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. 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.

- 700 kVA for 5 minutes
- 300 kVA for 5 minutes
- 600 kVA for 10 minutes
- 700 kVA for 8 minutes
- 1000 kVA for 2 minutes

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- S-2. How does the power factor of a induction motor improve with the increase in the applied load on the motor?
- S-3. (a) Why inter coolers are required for multi-stage reciprocating compressors?
(b) What is the purpose of an after cooler in a compressor?
- S-4. Chilled water enters evaporator at 13°C and leaves at 10°C. The flow rate of chilled water was measured as 330 m³/hr. Calculate the tons of refrigeration capacity.
- S-5. A fan is delivering 15,000 Nm³/hr. of air at static pressure rise of 60 mm WC. If the fan static efficiency is 60%, find out the shaft power of the fan.
- S-6. Explain briefly the difference between static and dynamic head of a centrifugal pumping system.
- S-7. List at least 5 factors which affect cooling tower performance.
- S-8. Is it advisable to install a servo transformer for controlling the operating voltage of the lighting circuit? Justify your answer.
- S-9. Briefly describe the principle of variable frequency drives used along with squirrel cage induction motors.
- S-10. What are the advantages of parallel operation of DG sets?

..... **End of Section – II**

Section – III: LONG DESCRIPTIVE QUESTIONS

Marks: 5 x 10 = 50

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

- L-1. A 15 kW, 415 V, 4 pole, 50 Hz, 3 phase squirrel cage induction motor has a full load efficiency of 92% and power factor of 0.90. Find the following if the motor operates at full load rated values.
- a) current drawn by the motor
b) input power in kW
c) RPM at a full load slip of 0.8%

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L-2. In an engineering industry, a 250 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:

- a) compressor on load timing is 15 seconds and unloading pressure is 7 kg/cm²g
- b) compressor power drawn during on load is 40 kW
- c) compressor unload timings and loading pressure are 30 seconds and 6.5 kg/cm² g respectively.

Find out the following:

- (i) % air leakage in the system
- (ii) leakage quantity in cfm.
- (iii) power lost due to leakage

L-3. A water pump is delivering 250 m³/hr at ambient conditions. The impeller diameter is trimmed by 10% and its speed is reduced by 20%. Find out the water flow at the changed conditions.

L-4. (a) What is meant by luminous efficacy ?

(b) Highlight the advantages of high frequency (HF) electronic ballasts in place of conventional ballasts.

L-5. List ten energy saving opportunities in a compressed air system.

..... End of Section – III