Paper 4: Energy Performance Assessment for Equipment and Utility Systems

Section A

Tick appropriate answer of the following questions on the top page. lx20=20

1. Reducing balance depreciation method allows
   A. higher depreciation during the initial year
   B. lower depreciation during the initial years
   C. equal depreciation in all years over the life of the project
   D. increasing depreciation over the life of the project
2. A company can sell each unit of its product at Taka 15. The variable cost per unit is Taka 12 and the fixed cost for the company is Taka 600,000. What is the number of units the company should produce and sell to break even?
   A. 150,000 C. 250,000
   B. 200,000 D. 300,000
3. A project requires an investment of $2,300 and generates cash flows of $600, $750, $800, $1,000 over years one through four. Calculate the project's payback period and discounted payback period at a rate of 14%.
   A. 3.15 years; never C. 4 years; 0 years
   B. 2 years; 4 years D. 3 years; 1 year
4. If the effective annual rate of interest is known to be 16.08% on a debt that has quarterly payments, what is the annual percentage rate?
   A. 4.02% C.14.50%
   B. 10.02% D.15.l9%
5. Standard NPV analysis is static because it ignores
   A. options to expand or abandon C. scenario analysis
   B. sensitivity analysis D. break even analysis
6. Two investments are mutually exclusive
   A. if they affect each other's profitability
   B. if either of the two investments cannot be selected
   C. if they cannot be selected for unequal life of the projects
   D. if one is adopted then the other one cannot be adopted
7. A hotel building has four floors each of 1000 m2 area. If the interior lighting power allowance for the hotel building is 43000W, the Lighting Power Density (LPD) is
   A. 10.75 C. 43
   B. 0.09 D. data insufficient
8. The efficiency of variable speed drives generally
   A. decreases with speed C. increases with speed
   B. remains constant with change in speed D. none of these
9. Information that is required to determine the size of VFD power converter is

A. full load amperage rating C. both (A) and (B)
B. system configuration D. both (A) and (B) along with operating voltage

10. Before starting the measurement of light, care should be taken so that
A. flow of light is not blocked C. windows are open
B. no dirt is on the floor D. all of these

11. Which one of the following components is necessary for VFD power converter?
A. rectifier C. inverter
B. controller D. all of these

12. Engine oil at 150 degree Celsius is cooled to 80 degree Celsius in a parallel flow heat exchanger by water entering at 25 degree Celsius and leaving at 60 degree Celsius. Estimate the exchanger's effectiveness.
A. 0.56 C.0.66
B. 0.76 D.0.86

13. Air density at 0ºC is l.293 kg/m^3, calculate the corrected air density at 40ºC
A. 0.032 kg/ m^3 C. 1.482 kg/ m^3
B. 1.128 kg/ m^3 D. none of these

14. Calculate the recoverable waste heat (Q, in kCal/hour) from flue gases using the following parameters:
flow rate of the substance: 2000 m3/hr,
density of the flue gas: 0.9 kg/nr'
specific heat of the substance: 0.20 kCal/kg "C
temperature difference: 120°C
recovery factor: 50%
A. 21600 C.25600
B. 43200 D.34000

15. A two stage reciprocating compressor is operating at an ambient temperature of 30°C. At which 2nd stage inlet temperature, the compressor will consume least power?
A. 80°C C. 55°C
B. 75°C D. 65°C

16. If the speed of centrifugal fan is reduced to 80% of its rated speed then the power drawn will be ____ % of its rated power
A. 80% C.40%
B. 51.2 % D.64%

17. A centrifugal fan is delivering 12.65 m^3/s of air at a pressure head of 205 mmWC. Power input to the shaft of the pump is 67.65 kW. What is the fan static efficiency?
A. 37.58 % C. 38.33 %
B. 46.19 % D. 42.93 %

18. For an AHU, the filter area is 2 m^2, air velocity is 2.5 m/s. The enthalpy of air at the inlet and outlet is 80 kJ/kg and 60 kl/kg, respectively. If density of air is 1.25 kg/m^3 what is the ton of refrigeration of this AHU?
A. 25.5 TR C. 45.5 TR

B. 35.5 TR D. 55.5 TR

19. If the speed of a centrifugal pump is doubled, its power consumption increases by ____ times
    A. No change C. Two
    B. Four D. Eight
20. A fan with 25 cm pulley diameter is driven by a 2940 rpm motor through a V-belt system. If the motor pulley is reduced from 20 cm to 15 cm keeping the motor rpm and fan pulley diameter the same, the fan speed will be reduced by
    A. 1176 rpm C. 588 rpm
    B. 1764 rpm D. none of these

Section B: Short Question

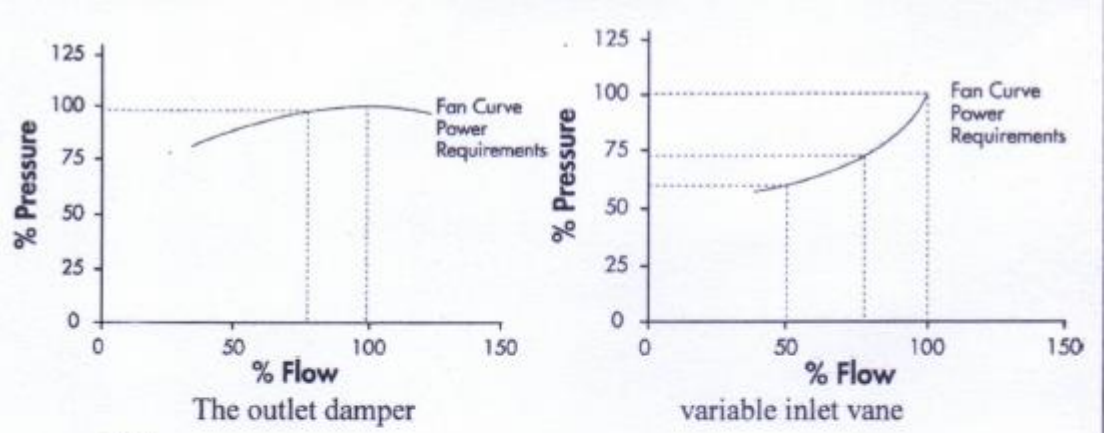
1. Using the data given the following table, calculate the estimated return on investment period of a replacement of 25 HID 400 W by 25 LED 150 W 5 lighting fixtures? 05

	LED	HID
Number of fixtures (qty)	25	25
Warts per fixture (W)	150W	400W
Daily operational hours (h)	12	12
Fixture costs (BDT)/LED	30000	
Energy price (BDT)	8	8

2. A boiler surface temperature is 80ºC and ambient temperature is 80ºC. If wind velocity is 3.8 m/s, find out the losses. 05

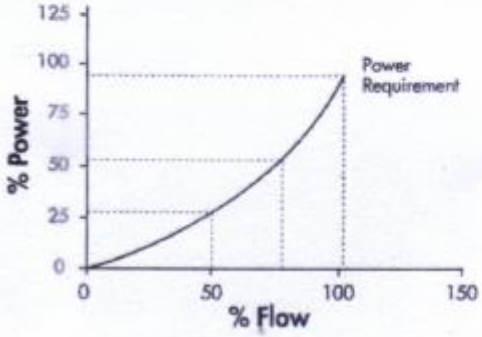
Section C: Long Descriptive Question

1. A fan operating at 300 RPM producing a 100% percent flow rating of 2,500 m^3/min, with a motor shaft power requirement of 25 kW. The fan will operate 8,000 hours per year. The energy cost is 8 BDT/kWh. Determine the potential savings between (i) the outlet damper (ii) variable inlet vane, and (iii) a VFD. Power requirement curves of the three methods and duty cycle data is given in the table. 10



The outlet damper

variable inlet vane



VFD

Flow	Duty Cycle
100%	20%
75%	40%
50%	40%

load profile of the fan

2. A plant's ventilation system used 10, 40-hp motors on a 24/7 basis except for a 2-week shut down in a year. The current motors are 85% efficient at rated/full load. Management is considering updating the motors with 93%-efficiency motors at $2000 each. They pay 6 cents/kWh for electricity. Assume load has been closed to rated/full load. What is the payback period and ROI? 10

3. A liquid waste stream has a flow rate of 3.5 kg/s and a temperature of 7°C with a specific heat capacity of 4190 J/kgK. Heat recovered from the hot waste stream is used to pre-heat boiler make-up water. The flow rate of them e-up water is 2 kg/s, its temperature is 10°C and its specific heat capacity is 4190 J/kgIK. The overall heat transfer coefficient of the heat exchanger is 800 W/m^2K. If a make-up water exit temperature of 50°C is required, and assuming that there is no heat losses from the exchanger, determine 10

    1) the heat transfer rate,
    2) the exit temperature 'of the effluent and
    3) the area of the heat exchanger required

4. An industrial compressor of capacity 2000 m^3/hr is in operation. Free Air Delivery (FAD) test of the compressor was carried out by filling the receiver. The test and other relevant data are listed below. 10

Receiver capacity	: 11 m^3
Interconnecting pipe	: 1 m^3
Atmospheric pressure	: 1.03 kg/cm^2 (abs)
Initial pressure in receiver	: 1.0 kg/ cm^2 (abs)
Inlet air pressure to compressor	: 1.0 kg/ cm^2 (abs)
Final pressure	: 5.5 kg/ cm^2 (abs)
Time taken to fill the receiver	: 3 minutes
Inlet air temperature	: 30°C
Air temperature in the receiver	: 40 °C
Motor rpm (N_1)	: 1400 rpm
Motor pulley dia. (D_1)	: 300 mm
Compressor rpm (N_2)	: 700 rpm
Compressor Pulley dia. (D_2)	: 600mm
Average loading time	: 40 minutes per hour
Average unloading time	: 20 minutes per hour
Power consumption during loading	: 180 kW
Power consumption during unloading	: 50 kW
Cost of Electricity	: 10.00 BDT per kW-hr

Using the above data, calculate:

(a) Operating Free Air Delivery (FAD) of the compressor
(b) Cost of energy per day (24 hrs operation).
(c) The Plant management is interested in reducing the unloading time of the compressor by reducing the pulley diameter of the motor. Determine the speed of the compressor appropriate for a cycle of 15 minutes unloading and 45

minutes loading and accordingly calculate the diameter of the pulley of the motor.

(d) Estimate the hourly power consumption and energy savings after replacement of the pulley. annual 8200 operating hours of the compressor. Also consider that the power consumption is 140 kW during loading and 40 kW during unloading.

5. A vapor compression refrigeration cycle with a refrigeration capacity of 7.9 kW operates with a condensing temperature of 35°C and an evaporating temperature of -10°C, the enthalpy values at the entry and exit of the evaporator are 85.75 kJ/kg and 243.4 kJ/kg, respectively. The superheated refrigerant vapor at the end of the compression process has an enthalpy of284.4 kl/kg. Determine 10

The mass flow rate of refrigerant, compressor power in kW, and COP of this refrigeration system;

Now, if the compressor is assumed to have an isentropic efficiency of 92%, determine the COP in this case, assuming that the other process parameters remain same.

6. A cement manufacturing company borrows BDT 1,500 million to purchase a new vertical roller mill (VRM) for its new production line. If the interest rate is 12% per annum and repayment period is 7 years.

Determine the additional cost of borrowing in case of compound interest rate compared to simple interest rate. Calculate the total repayment value 10 and quarterly repayment value in both case.

Now consider instead of borrowing, the company purchases the VRM and has the option of paying BDT 1,500 million now or BDT 2,000 million after 3 years. Which option is better? Consider discount factor of 12%. 10