Register Number.....

**B.E. DEGREE EXAMINATIONS: APRIL / MAY 2009**

Fourth Semester

**MECHANICAL ENGINEERING**

**U07ME403 Thermal Engineering**

**Time: Three Hours** **Maximum marks: 100**

(Use of steam table / Mollier chart, Refrigerant property tables and Psychometric chart is permitted)

**Answer ALL the Questions:-**

**PART A (20 x 1 = 20 Marks)**

1. The mechanical system which works on Otto cycle is

   A. Diesel engine B. Gas turbine C. Petrol engine D. Steam turbine

2. For the same compression ratio, efficiency of Otto cycle when compared to Diesel is

   A. Higher B. Lower C. Equal D. None of these

3. An engine has 150mm of bore and 225 mm of stroke. If the clearance volume is 1.25 $x10^{-3}$ $m^3$, the compression ratio will be

   A. 4.18 B. 4.81 C. 8.41 D. 8.14

4. In a dual cycle, the heat addition process is

   A. Constant volume B. Constant pressure

   C. Isothermal D. Constant volume and Constant pressure

5. In how many revolutions of crank shaft, one cycle of operation is completed in a 4 stroke I.C. engine?

   A. One B. Two C. Three D. Four

6. Volumetric efficiency of an I.C engine is defined as the ratio of

   A. Stroke volume to clearance volume B. Actual volume to clearance volume

   C. Clearance volume to stroke volume D. Actual volume to stroke volume

7. Fuel injector is used in

   A. S.I. engines B. Gas engines C. C.I. engines D. None of these

8. Which number rating is used to determine the ignition quality of fuels of S.I. engines?

   A. Cetane B. Octane C. Calorific value D. Volatality of fuel

9. The isentropic expansion of steam through nozzle for the steam initially superheated at Inlet is approximated by the equation

   A. $pv^{1.3} = C$ B. $pv^{1.125} = C$ C. $pv^{1.4} = C$ D. $pv = C$

10. The condition for maximum discharge through a nozzle is

A. $\frac{P_2}{P_1} \leq \left(\frac{2}{n+1}\right)^{\frac{n-1}{n}}$

B. $\frac{P_2}{P_1} \leq \left(\frac{1}{n+1}\right)^{\frac{n}{n+1}}$

C. $\frac{P_2}{P_1} \leq \left(\frac{2}{n+1}\right)^{\frac{n}{n+1}}$

D. $\frac{P_2}{P_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$

11. Steam turbines are governed by

A. Throttle B. Nozzle control C. By – pass D. All of the above

12. In impulse turbine the steam expands through the

A. Nozzle B. Blades

C. Partly in nozzle and partly in blades D. All of the above

13. The maximum theoretical volume that can be delivered by a compressor is called

A. Free air delivery B. Compressor capacity

C. Swept volume D. None of these

14. The actual volume of the air sucked by the compressor during its suction stroke is

A. Less than swept volume B. More than swept volume

C. Equal to swept volume D. Equal to cylinder volume

15. The pressure during suction stroke is

A. Equal to atmospheric pressure B. Less than atmospheric pressure

C. More than atmospheric pressure D. More or less than atmospheric pressure

16. In centrifugal compressor the pressure developed depends on

A. Impeller tip velocity B. Inlet temperature

C. Compression index D. All of the above

17. One tonne of refrigeration is equivalent to

A. 100 KJ/min B. 200 KJ/min C. 110 KJ/min D. 210 KJ/min

18. The C.O.P of a Carnot refrigerator is equal to

A. $\frac{T_2}{T_1 + T_2}$ B. $\frac{T_1}{T_1 - T_2}$ C. $\frac{T_2}{T_1 - T_2}$ D. $\frac{T_1}{T_1 + T_2}$

19. Cooling and dehumidification process in air conditioning cycles

A. Decreases dry bulb temperature B. Decreases relative humidity

C. Increases dry bulb temperature D. Increases relative humidity

20. In split air conditioning system

A. Condenser is inside the room B. Only evaporator is inside the room

C. Compressor is inside the room D. All are inside the room

## PART B (5 x 16 = 80 Marks)

21. (a) The compression ratio in an air standard Otto cycle is 6. The initial temperature and pressure of the air are $40^0$C and 1 bar. 825 kJ of heat is supplied per kg of air at the end of the compression. Calculate

i) The temperature and pressure at the end of each process of the cycle.

ii) Thermal efficiency

iii) Mean effective pressure

**(OR)**

21. (b) In a Brayton cycle, air enters the compressor at 100 kPa and $20^0$C. The pressure of air leaving the compressor is 3.5 bar and the temperature at the turbine inlet is $600^0$C. Determine per kg of air

i) Cycle efficiency

ii) Heat added

iii) Work available at the shaft

iv) Heat rejected in the cooler and

v) Temperature of air leaving the turbine.

22. (a) Dry saturated steam at 2.8 is expanded through a convergent nozzle to 1.7 bar. The exit area is 3 $cm^2$. Estimate the exit velocity and the mass flow rate, assuming

i) Isentropic expansion and

ii) Super saturated flow

**(OR)**

22. (b) The following data refer to a single stage impulse turbine: Isentropic nozzle heat drop = 251 kJ/kg, nozzle efficiency = 90 %, nozzle angle = $20^0$, ratio of blade speed to whirl component of steam speed = 0.5, blade velocity coefficient = 0.9, the velocity of steam entering the nozzle = 20 m/s. Determine

i) The blade angles at the inlet and outlet if the steam enters into the blades without shock and leaves the blades in an axial direction.

ii) Blade efficiency

iii) Power developed and axial thrust if the steam flow is 8 kg / s

23. (a) (i) Give any four classifications of I.C. engines (4)

(ii) Explain with a neat sketch the operation of a battery ignition system (12)

**(OR)**

23. (b) (i) Explain any six properties of lubricant (6)

(ii) Explain with a neat sketch the operation of a wet sump lubrication system (10)

24. (a) A single stage compressor takes 1 $m^3$ of air per minute at 1 bar and delivers it at 7 bar. Th law of compression is $pv^{1.3}$ = Constant. Calculate the indicated power, neglecting th clearance. If the speed of the compressor is 300 rpm and stroke to bore ratio is 1. calculate the

i) Cylinder dimension

ii) Power required if the mechanical efficiency of compressor is 85% and motor Transmission efficiency is 90%

**(OR)**

24. (b) (i) Enumerate the difference between rotary air compressor and reciprocating a compressor (6)

(ii) Deduce the condition for minimum work input for a two stage reciprocating air compressor with inter cooler (10)

25. (a) 28 tonnes of ice from and at $0^0$C is produced per day in an ammonia refrigerator. Th temperature range is from $25^0$C to – $15^0$C. The vapour is dry and saturated at the end c compression and an expansion valve is used. Assuming a coefficient of performance c 62% of the theoretical, calculate

i) The power required to drive the compressor

| Temp | Enthalpy kJ / kg | | Enthalpy of liquid kJ / kg K | Entropy of vapour kJ / kg K |
|---|---|---|---|---|
| | Liquid | Vapour | | |
| 25 | 100.04 | 1319.22 | 0.3473 | 4.4852 |
| -15 | -54.56 | 1304.99 | - 2.1338 | 5.0585 |

Take latent heat of ice = 335 kJ / kg

**(OR)**

25. (b) An office is to be air conditioned for staff of 25 when the outdoor conditions are $29^0$ DBT and 73% RH. If the quantity of outdoor air supplied is 0.5 $m^3$/ min / person, find

i) The capacity of cooling and heating coil.

ii) The amount of water removed if the required comfort conditions are $21^0$C DBT an 59% RH. Air is conditioned first by cooling and dehumidifying and then heating

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