KUMARAGURU
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Register Number:……..

B.E DEGREE EXAMINATIONS: NOV / DEC 2014

(Regulation 2009)

Forth Semester

AUTOMOBILE ENGINEERING

AUE104**:** Applied Thermodynamics and Heat Transfer

(HMT Data Book is Permitted)

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The thermal efficiency of theoretical Otto cycle
   a) Increases with increase in compression ratio
   b) Increases with increase in isentropic index γ
   c) Does not depend upon the pressure ratio
   d) Follows all the above
2. What is the cut off ratio of a diesel engine with compression ratio 14 if the fuel cut-off is 8% of the stroke volume?
   a) 1.65
   b) 1.75
   c) 2.01
   d) 2.04
3. In Reciprocating Air Compressor the clearance ratio is given by
   a) $\frac{Total\ volume\ of\ cylinder}{Clearance\ volume}$
   b) $\frac{Swept\ volume\ of\ cylinder}{Clearance\ volume}$
   c) $\frac{Clearance\ volume}{Swept\ volume\ of\ cylinder}$
   d) $\frac{Clearance\ volume}{Total\ volume\ of\ cylinder}$
4. One Tonne of Refrigeration is equal to
   a) 3.5 kJ/Sec
   b) 3.5 kJ/min
   c) 210 kJ/Sec
   d) 1000 kJ/ Sec
5. Which equation below is used to determine the heat flux for convection?
   a) $-kA\frac{dT}{dx}$
   b) -kgrad T
   c) $h(T_2-T_1)$
   d) $\varepsilon\sigma T^4$

6. Consider a medium in which the heat conduction equation is given in its simplest form as $\frac{\partial^2 T}{\partial x^2} = \frac{1}{\alpha}\frac{\partial T}{\partial t}$

   a) Is heat transfer steady or transient?
   b) Is heat transfer two, or three-dimensional?
   c) Is there heat generation in the medium?
   d) Is the thermal conductivity of the medium constant or variable?

7. The ratio of convective heat transfer to conduction heat transfer is called

   a) Prandtl Number
   b) Nusselt Number
   c) Reynolds Number
   d) Mach Number

8. Free convection heat transfer is significantly affected by

   a) Reynolds Number
   b) Prandtl Number
   c) Grashof Number
   d) Stanton Number

9. The emissive power of a body depends upon its

   a) Temperature
   b) Wave Length
   c) Physical Nature
   d) All of the Above

10. The large part of thermal radiation between 0.8 µm 800 µm is called the

   a) Ultraviolet radiation
   b) Visible light
   c) Infrared radiation
   d) Microwave Radiation

PART B (10 x 2 = 20 Marks)

11. The efficiency of an Otto cycle is 60% and $\gamma = 1.5$. What is the compression ratio?
12. What are the assumptions made in air standard efficiency?
13. Define free air delivery.
14. What are the properties of good refrigerant?
15. Define Nusselt number.
16. Write the general heat conduction equation for plane wall.
17. What is hydro dynamic boundary layer?
18. Define natural convection and write any three examples.
19. State Stephen Boltzmann's law
20. The filament of a 60 W light bulb may be considered a black body radiating into a black enclosure at 60^0C. The filament diameter is 0.1mm and length is 50 mm. Considering radiation, Determine the filament temperature.

PART C (5 x 14 = 70 Marks)

21. a) An engine with 200 mm cylinder diameter and 300 mm stroke works on theoretical diesel cycle. The initial pressure and temperature of air used for 1 bar and 27^0 C. The cut off is 8% of the stroke. Determine

(i) Pressure and temperature at all salient points

(ii) Theoretical air standard efficiency

(iii) Mean effective pressure

(iv) Power of the engine if the working cycle per minute is 380.

Assume the compression ratio is 15 and working fluid is air.

(OR)

b) Consider an air standard Brayton cycle in which the air enters the compressor at 1 bar and 20^0 C. The pressure of air leaving the compressor is 3.5 bar and the temperature at turbine inlet is $600\ ^0$ C. Determine per kg of air:

(i) Efficiency of the cycle

(ii) Heat supplied to air

(iii) Work available at the shaft

(iv) Heat rejected in the cooler and

(v) Temperature of air leaving the turbine

22. a) Following data relate to a performance test of a single acting 14 cm x 10 cm reciprocating compressor:

Suction pressure= 1 bar, Suction temperature = 20^0 C, Discharge pressure= 6 bar, Discharge temperature= $180\ ^0$ C, Speed of compressor= 1200 rpm,

Shaft power = 6.25 kW, mass of air delivered = 1.7 kg/min.

Calculate the following:

(i) The actual volumetric efficiency

(ii) The indicated power

(iii) Isothermal efficiency

(iv) Mechanical efficiency and

(v) The overall isothermal efficiency

(OR)

b) Explain working principles of vapour compression refrigeration system and draw the p-H and T-s diagram and indicate the various process

23. a) (i) Steam at 350^0 C flowing in a pipe (k=80 W/mK) 5 cm ID, 5.6 cm OD is covered with 3 cm thick insulation (k=0.05 W/mK). (10)

Heat is lost to the surrounding at 5^0 C by natural convection and radiation with combined h_0 = 20 W/m^2K and h_i = 60 W/m^2K. Find

a) The rate of heat loss from the pipe per unit length

b) The temperature drops across the pipe and the insulation

(ii) Explain different modes of heat transfer. (4)

(OR)

b) (i) A copper fin (k= 396 W/mK) 0.25 cm in diameter protrudes from a wall at 95^0C into ambient air at 25^0C. The heat transfer coefficient for free convection= 10 W/m^2K. Calculate the heat loss if. (10)

a) The fin is infinitely long

b) The fin is 2.5 cm long and the coefficient at the end is the same as around the circumference

(ii) Explain the following: (4)

a) Unsteady heat conduction

b) Extended surfaces(fins)

24. a) Water at 10^0C flows over a flat plate (at 90^0C) measuring 1m x 1m, with a velocity of 2 m/s. Find

(i) The length of plate over which the flow is laminar

(ii) The rate of heat transfer from the entire plate

(OR)

b) Derive the free convection heat transfer equation with the help of Buckingham π theorem.

25. a) Explain the following:

(i) Kirchoff law (2)

(ii) Black body radiation (4)

(iii) Grey body radiation and (4)

(iv) Radiation shield (4)

(OR)

b) Emissivities of two large parallel plates maintained at 800^0C and 300^0C are 0.3 and 0.5 respectively. Find the net radiant heat exchange per square meter of the plate. If a polished aluminum shield (ε =0.05) is placed between them, Find the percentage reduction in heat transfer. Find also the shield temperature.

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