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**End Semester Examination – Nov/Dec – 2018**

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| **Code : 17ME2058** |  | **Duration :** | **3hrs** |
| **Sub. Name : FUNDAMENTALS OF THERMAL AND FLUID**  **SCIENCES** |  | **Max. marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

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| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | **Marks** |
| 1. | a. | 1.5 kg of liquid having a constant specific heat capacity of 2.5 kJ/kgK is stirred in a well-insulated chamber causing the temperature to rise by 15oC. Find ΔE and W for the process. | CO1 | 10 |
| b. | Propane at 100oC and 120 kPa with a volume of 2 m3 is compressed using an isothermal process until the pressure is 600 kPa. Determine the work done during this process and the heat transfer. Propane is an ideal gas with a gas constant of R = 0.1886 kJ/kg.K. | CO1 | 10 |
| (OR) | | | | |
| 2. | a. | A heat engine is required to produce 110 kW by accepting 150 kW from a heat source. Determine the i) amount of heat rejected to the low-temperature reservoir, and ii) the efficiency of the engine. | CO1 | 10 |
| b. | A Carnot heat engine receives 1 MJ/s of heat from a source at 1000oC and rejects 0.4 MJ/s of heat to a sink of unknown temperature. Calculate the temperature of the heat sink and the efficiency of the engine. | CO1 | 10 |
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| 3. | a. | A long 8-cm-diameter steam pipe whose external surface temperature is 90°C passes through some open area that is not protected against the winds. Determine the rate of heat loss from the pipe per unit of its length when the air is at 1 atm pressure and 7°C and the wind is blowing across the pipe at a velocity of 50 km/h. | CO3 | 10 |
| b. | Consider a large plane wall of thickness L=0.2 m, thermal conductivity k=1.2 W/m · °C, and surface area A=15 m2. The two sides of the wall are maintained at constant temperatures of T1= 120°C and T2=50°C, respectively. Determine (a) the variation of temperature within the wall and the value of temperature at x=0.1 m and (b) the rate of heat conduction through the wall under steady conditions. | CO3 | 10 |
| (OR) | | | | |
| 4. | a. | The composite wall of an oven consists of three materials, two of which are of thermal conductivity kA=20 W/mK, kC=50 W/mK, and known thickness, LA=0.30 m and LC=0.15 m. The third material B, which is sandwiched between the materials A and C, is of known thickness LB=0.15 m, but of unknown thermal conductivity kB. Under steady-state conditions, the outer surface temperature is To=20oC, an inner surface temperature of Ti=600oC, and an oven air temperature of T∞=800oC. The inside convection coefficient h is known to be 25 W/m2K. Determine the value of kB. | CO3 | 10 |
| b. | Engine oil at 40oC flows with a free stream velocity of 1 m/s over a 2 m long plate whose surface is maintained at a uniform temperature of 90oC. Determine the rate of heat transfer per unit width of the plate. | CO3 | 10 |
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| 5. |  | A cross-flow heat exchanger with both fluids unmixed is used to heat water from 50oC to 90oC, flowing at the rate of 1.0 kg/s. Determine the overall heat transfer coefficient if the hot engine oil (cp=1.9 kJ/kgK) flowing at the rate of 3 kg/s enters at 100oC. The heat transfer area is 20 m2. | CO3 | 20 |
| (OR) | | | | |
| 6. |  | Water is heated from 30oC to 90oC in a counter flow double-pipe heat exchanger. Water flows at the rate of 1.2 kg/s. The heating is accomplished by a geothermal fluid which enters the heat exchanger at 160oC at a mass flow rate of 2 kg/s. The inner tube is thin-walled and has a diameter of 15 mm. If the overall heat transfer coefficient of the heat exchanger is 600 W/m2K, determine the length of the heat exchanger required for the purpose. | CO3 | 20 |
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| 7. | a. | Find the surface tension in a soap bubble of 40 mm diameter when the inside pressure is 2.5 N/m2 above atmospheric pressure. | CO2 | 10 |
| b. | Calculate the capillary rise in a glass tube of 2.5 mm diameter when immersed vertically in i) water and ii) mercury. Take surface tension for water as 0.0725 N/m and 0.52 N/m for mercury in contact with air. | CO2 | 10 |
| (OR) | | | | |
| 8. | a. | If a velocity distribution over a plate is given by  in which u is the velocity in m/s at a distance of y metres, determine the shear stress at y = 0 m and y = 0.15 m. Take dynamic viscosity of fluid as 8.63 poise. | CO2 | 10 |
| b. | What are the gauge pressure and absolute pressure at a point 3 m below the free surface of a liquid having a density of 1.53 x 103 kg/m3 if the atmospheric pressure is equivalent to 750 mm of mercury? | CO2 | 10 |
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|  | | **Compulsory**: |  |  |
| 9. |  | The velocity vector in a fluid flow is given . Find the velocity and acceleration of a fluid particle at (2,1,3) at time t=1. | CO2 | 20 |