Problems for FE Thermodynamics Review

1. A 300-m^3 rigid tank is filled with saturated liquid-vapor mixture of water at 200 kPa. If 75 percent of the mass is liquid, the total mass in the tank is:

(a) 451 kg (b) 556 kg (c) 300 kg (d) 331 kg (e) 195 kg

2. The pressure of an automobile tire is measured to be 190 kPa (gage) before a trip and 215 kPa (gage) after the trip, both at a location where the local atmospheric pressure is 95 kPa. If the air temperature in the tire is 25 ˚C before the trip, the air temperature after the trip is:

(a) 27.2 ˚C (b) 64.2 ˚C (c) 51.1 ˚C (d) 28.3 ˚C (e) 25.0 ˚C

3. A fan is to accelerate quiescent air to a velocity of 12 m/s at a rate of 3 m^3/min. If the density of air is 1.156 kg/m^3, the minimum power that must be supplied to the fan is:

(a) 4.14 W (b) 1.2 W (c) 9.2 W (d) 4.04 W (e) 2.3 W

4. Water is boiling at 1 atm pressure in a stainless steel pan on an electric range. It is observed that 2 kg of the liquid water evaporates in 30 min. The rate of heat transfer to the water is:

(a) 2.51 kW (b) 2.32 kW (c) 2.97 kW (d) 0.47 kW (e) 3.12 kW

5. A 0.5-m^3 rigid tank contains nitrogen gas at 600 kPa and 300 K. Now the gas is compressed isothermally to a volume of 0.1 m^3. The work done on the gas during this compression process is:

(a) 720 kJ (b) 483 kJ (c) 240 kJ (d) 175 kJ (e) 143 kJ

6. A well-sealed room contains 60 kg of air at 200 kPa and 25 ˚C. Now solar energy enters the room at an average rate of 0.8 kJ/s while a 120-W fan is turned on to circulate air in the room. If heat transfer through the walls I negligible, the air temperature in the room in 30 min. will be:

(a) 25.6 ˚C (b) 49.8 ˚C (c) 53.4 ˚C (d) 52.5 ˚C (e) 63.4 ˚C

7. A 2-kW electric resistance heater submerged in 5-kg water is turned on and kept on for 10 min. During the process, 300 kJ heat is lostr from the water. The temperature rise of the water is:

(a) 0.4 ˚C (b) 43.1 ˚C (c) 57.4 ˚C (d) 71.8 ˚C (e) 180 ˚C

8. In a heating system, cold outdoor air at 7˚C flowing at a rate of 4 kg/min is mixed adiabatically with heated air at 70˚C flowing at a rate of 3 kg/min. The exit temperature of the mixture is:

(a) 34 ˚C (b) 39 ˚C (c) 45 ˚C (d) 63 ˚C (e) 77 ˚C

9. Steam is compressed by an adiabatic compressor from 0.2 MPa and 150˚C to 0.8 MPa and 350 ˚C at a rate of 1.30 kg/s. The power input to the compressor is:

(a) 511 kW (b) 393 kW (c) 302 kW (d) 717 kW (e) 901 kW

10. Refrigerant R-134a at 1.4 MPa and 90 ˚C is throttled to a pressure of 0.6 MPa. The temperature of the refrigerant after throttling is:

(a) 22˚C (b) 56 ˚C (c) 82˚C (d) 80˚C (e) 90˚C

11. Steam is condensed at a constant temperature of 30˚C as it flows through the condenser of a power plant by rejecting heat at a rate of 55 MW. The rate of entropy change of steam as it flows through the condenser is:

(a) -1.83 MW/K (b) -0.18 MW/K (c) 0 MW/K (d) 0.56 MW/K (e) 1.22 MW/K

12. Helium gas is compressed from 1 atm and 25 ˚C to a pressure of 10 atm adiabatically. The lowest temperature of helium after compression is :

(a) 25 ˚C (b) 63 ˚C (c) 250 ˚C (d) 384 ˚C (e) 476 ˚C

13. Liquid water enters an adiabatic piping system at 15˚C at a rate of 8 kg/s. If the water temperature rises by 0.2˚C during flow due to friction, the rate of entropy generation in the pipe is:

(a) 23 W/K (b) 55 W/K (c) 68 W/K (d) 220 W/K (e) 443 W/K

14. Air in an ideal Diesel cycle is compressed from 2 to 0.13 L, and then it expands during the constant pressure heat addition process to 0.30 L. Under cold air standard conditions, the thermal efficiency of this cycle is:

(a) 41% (b) 59% (c) 66% (d) 70% (e) 78%

15. An ideal Brayton cycle has a net work output of 150 kJ/kg and a back-work ratio of 0.4. If both the turbine and the compressor had an isentropic efficiency of 85 percent, the net work output of the cycle would be:

(a) 74 kJ/kg (b) 95 kJ/kg (c) 109 kJ/kg (d) 128 kJ/kg (e) 177 kJ/kg

16. A simple ideal Rankine cycle operates between the pressure limits of 10 kPa and 5 MPa, with a turbine inlet temperature of 600 ˚C. The mass fraction of steam that condenses at the turbine exit is:

(a) 6% (b) 9% (c) 12% (d) 15% (e) 18 %

17. Consider a refrigerator that operates on the vapor compression refrigeration cycle with R-134a as the working fluid. The refrigerant enters the compressor as saturated vapor at 160 kPa, and exits at 800 kPa and 50˚C, and leaves the condenser as saturated liquid at 800 kPa. The coefficient of performance of the refrigerator is:

(a) 2.6 (b) 1.0 (c) 4.2 (d) 3.2 (e) 4.4