

National Institute of Technology Silchar
Mid Semester Examination, March – 2021

Subject: Applied Thermodynamics
Branch: Mechanical Engineering
Full Marks: 20

Code: ME 206
Semester: 4th
Time: 1 Hour

Answer the following questions

Figure in the right margin indicated full marks for the question

- 1 (i) The change in entropy over the complete Carnot cycle [1]
(a) Increases
(b) Decreases
(c) Remains unchanged
(d) None of the above
- (ii) The adiabatic enthalpy drop across the prime mover of the Rankine cycle is 840 kJ/kg. If the back work ratio is 0.1, the specific steam consumption (kg/kWh) is [1]
(a) 4.8
(b) 4.2
(c) 3.8
(d) 5.0
- (iii) Isobaric lines in the superheated region of the Mollier diagram will have [1]
(a) Positive slope
(b) Negative slope
(c) Zero slope
(d) May have positive or negative slope
- (iv) Consider the following statements: [1]
The efficiency of the Rankine cycle can be increased by (1) increasing the temperature of the working fluid at which heat is added (2) increasing the pressure of the working fluid at which heat is added (3) decreasing the temperature of the working fluid at which heat is rejected. Which of these statements is / are correct?
(a) 2 and 3
(b) 1 alone
(c) 1 and 2
(d) 1, 2 and 3
- (v) Maximum work is done in compressing air when the compression is [1]
(a) Isothermal
(b) Adiabatic
(c) Polytropic
(d) Same in all the process
- (vi) The volumetric efficiency of a reciprocating compressor decreases [1]
(a) With the increase in compression index
(b) With the decrease in compression index
(c) With the decrease in pressure ratio
(d) None of the above

- 2 (i) A Carnot cycle with water as the working fluid is executed under the saturation dome between the pressure limits of 8 MPa and 20 kPa. Water changes from saturated liquid to saturated vapour during the heat addition process. The net work output of the cycle is [2]
(a) 494 kJ/kg
(b) 596 kJ/kg
(c) 845 kJ/kg
(d) 975 kJ/kg
- (ii) A simple Rankine cycle operates with boiler pressure of 3 Mpa and the condenser pressure of 50 kPa. The temperature of steam at inlet to the turbine is 350°C. Assuming ideal operation and processes, the thermal efficiency of the cycle will be [2]
(a) 7.7
(b) 17.7
(c) 27.7
(d) 37.7
- (iii) Steam at a pressure of 15 bar and a temperature of 250°C is expanded through a turbine to a pressure of 5 bar. It is reheated at constant pressure to a temperature of 200°C after which it completes its expansion through the turbine to an exhaust pressure of 0.1 bar, The theoretical efficiency is approximately [2]
(a) 33%
(b) 29%
(c) 25%
(d) 37%
- (iv) Consider a steam power plant that operates on the regenerative Rankine cycle with one open feed water heater. The enthalpy of steam is 3374 kJ/kg at the turbine inlet, 2797 kJ/kg at the location of bleeding, and 2346 kJ/kg at the turbine exit. The net power output of the plant is 120 MW and the fraction of steam bled off the turbine for regeneration is 0.172. If the pump work is negligible, the mass flow rate of steam at the turbine inlet is [2]
(a) 117 kg/s
(b) 126 kg/s
(c) 219 kg/s
(d) 268 kg/s
- (v) A reciprocating air compressor is required to compress 30 m³/min of air 1 bar and 27°C to a pressure of 16 bar. Assuming the value of the exponent as 1.32 and mechanical efficiency as 82%, the motor power required will be [2]
(a) 271 kW
(b) 192 kW
(c) 241 kW
(d) 213 kW

- (vi) A 3-stage compressor is used to compress air from 1.0 bar to 36 bar. The [2]
compression in all stages follows the law $p v^{1.25} = \text{constant}$. The temperature
of air at inlet of the compressor is 300 K. Neglecting the clearance and
assuming perfect inter cooling, to deliver 15 m^3 of air per minute, the
indicated power required in kW is
(a) 130.58
(b) 101.11
(c) 93.52
(d) 150.85
- (vii) A 2-stage air compressor with complete inter cooling delivers air to the [2]
mains at a pressure of 30 bar, the suction conditions being 1 bar and 15°C . If
both cylinders have the same stroke, for the efficiency of compression to be
maximum, the ratio of diameters of the cylinders is
(a) 3.16
(b) 2.34
(c) 2.85
(d) 3.52