

University of Mumbai

Examination Summer 2022

Program: Mechanical Engineering

Curriculum Scheme: REV- 2019 'C' Scheme

Examination: SE

Semester: III

Course Code: MEC305

Course Name: Thermodynamics

Time: 2 hour 30 Minutes

Max. Marks: 80

- N. B. :
1. All questions are **compulsory**.
 2. Assume suitable data if required and state it clearly.
 3. Use of Steam Table and Mollier diagram is permitted.

Q 1	Choose the correct option for following questions. All questions are compulsory and carry equal marks. 2 marks each
1	In case of a closed system
Option A	Neither mass nor energy can enter or leave system
Option B	both mass & energy can enter or leave system
Option C	mass cannot enter or leave but energy can enter or leave system
Option D	mass can enter or leave but energy cannot enter or leave system
2	A system undergoes a process in which heat supplied to system is 100 kJ and work done on the system by surrounding is 20 kJ, the change in internal energy is
Option A	80 kJ
Option B	120 kJ
Option C	-80 kJ
Option D	-120 kJ
3	A refrigerator having COP of 5 removes 10 MJ of heat from a cold body. Work Input required for refrigerator is?
Option A	2 MJ

Option B	0.5 MJ
Option C	50 MJ
Option D	15 MJ
4	300 kJ/s of heat is supplied at a constant fixed temperature of 290° C to a heat engine. 215 kJ/s of heat is rejected at a constant fixed temperature of 8.5 ° C.
Option A	Cycle is impossible
Option B	Cycle is reversible
Option C	Cycle is irreversible
Option D	Insufficient data
5	Which of the following is High Grade Energy?
Option A	Wind Energy
Option B	Nuclear Energy
Option C	Thermal Energy
Option D	Chemical Energy
6	Joule Thompson Coefficient is given by
Option A	$\left(\frac{\partial T}{\partial P}\right)_h$
Option B	$\left(\frac{\partial P}{\partial T}\right)_h$
Option C	$\left(\frac{\partial T}{\partial P}\right)_h$
Option D	$\left(\frac{\partial P}{\partial T}\right)_h$
7	Which of the following statement is not true ?

Option A	Dryness fraction(x) of wet steam is greater than zero & less than One
Option B	Point at which saturated liquid line meets saturated vapour line is Critical Point
Option C	Dryness fraction of superheated steam is greater than one
Option D	Point at which all phases exist is Triple Point
8	Reheating the steam before supplying to the steam turbine
Option A	Reduces heat supplied
Option B	Reduces heat rejected in condenser
Option C	Increases Turbine Work
Option D	Reduces Pump Work
9	In Bryton cycle, heat addition & heat rejection takes place at
Option A	Constant Pressure
Option B	Constant Volume
Option C	Constant Pressure & Constant Volume respectively
Option D	Constant Volume & Constant Pressure respectively
10	The discharge from nozzle is maximum and nozzle is said to be choked when
Option A	Mach Number < 1
Option B	Mach Number = 1
Option C	Mach Number > 1
Option D	Mach Number > 5

Q2	
A.	Solve any Two 5 Marks Each
i)	Explain principle of increase of entropy.
ii)	Steam at 15 bar and 300 °C is throttled to 10 bar before supplying to the steam turbine. It then undergoes isentropic expansion to 1 bar in the turbine. Determine isentropic

	heat drop and the condition of steam at exit from the turbine. Use enthalpy-entropy chart.
iii)	Explain (i) Availability (ii) Irreversibility (iii) Effectiveness (iv) Dead State
B.	Solve any One 10 Marks Each
i)	A mass of air initially at 206°C is at a pressure of 7 bar and has a volume of 0.03 m ³ . The air is expanded at constant pressure to 0.09 m ³ . A polytropic process with $n = 1.5$ is then carried out, followed by a constant temperature process which completes the cycle. All the processes are reversible. Sketch the cycle on P-V diagram and find the heat received and heat rejected in the cycle. Take $R = 0.287 \text{ kJ/kg K}$, $C_v = 0.713 \text{ kJ/kg K}$.
ii)	A reversible heat engine operates between two reservoirs at temperature of 600°C and 60°C. The engine drives the refrigerator which operates between the reservoirs at temperature of 60°C and -30°C. The heat transfer to the engine is 3MJ and the net work output of the combined engine and refrigerator plant is 380 kJ. Find heat transfer to the refrigerator and the net heat transfer to the reservoir at 60°C.

Q3	
A.	Solve any Two 5 Marks Each
i)	Explain limitations of Carnot vapour power cycle
ii)	Air at 320 kPa, 300 K and Mach Number = 0.6 flows through a duct. Determine the velocity, stagnation temperature & pressure.
iii)	State and explain Maxwell relations.
B.	Solve any One 10 Marks Each
i)	Air at 20°C and 1.05 bar occupies 0.025 m ³ . The air is heated at constant volume until the pressure is 2 bar and then cooled at constant pressure back to original temperature. Sketch the processes on T-S and P-V diagram and calculate the net entropy change.
ii)	A steam turbine is supplied with dry saturated steam at 25 bar and the exhaust takes place at 0.2 bar. For a steam flow rate of 10 kg/s, determine (i) Quality of steam at the end of expansion (ii) Turbine shaft work (iii) Power required to drive the pump (iv) The heat flow in the condenser (v) The Rankine efficiency

Q4	
A.	Solve any Two 5 Marks Each
i)	State and Explain steady flow energy equation.
ii)	Explain the effect of varying back pressure on nozzle performance.

iii)	Explain Lenoir cycle and Atkinson cycle using P-V & T-S Diagram.
B.	Solve any One 10 Marks Each
i)	In an air standard dual cycle, the pressure and temperature are 0.1MPa and 27°C. The compression ratio is 18. The pressure ratio for the constant volume part of the heating process is 1.5 and the volume ratio for the constant pressure part of heating is 1.2. Determine (i) Thermal efficiency (ii) Mean effective pressure.
ii)	Air at the rate of 25kg/min is compressed in centrifugal compressor from 1 bar to 2 bar. The temperature increases from 15°C to 105°C during compression. Determine actual and minimum power required to run the compressor. The surrounding air temperature is 15°C. Neglect the change in K.E and P.E.