BT MRE-II(R/S)-06-22-0776 Reg. No. [ | | | | | | | ]

**A**

# B.Tech. Degree II Semester Regular/Supplementary Examination in Marine Engineering June 2022

## 19-208-0202 APPLIED THERMODYNAMICS

*(2019 Scheme)*

Time: 3 Hours Maximum Marks: 60

Course Outcome

On successful completion of the course, the students will be able to:

CO1: Understand basics of thermodynamics and find the work done and heat transferred in different thermodynamic processes.

CO2: Understand the different types of boilers and vapour power cycles and calculate their efficiencies.

CO3: Gain knowledge on the working of steam nozzles and steam turbines and calculate the work output.

CO4: Identify the different ideal gas cycles used in IC engines and calculate their efficiencies.

CO5: Calculate the properties of gas mixtures as applied to air conditioning.

Bloom's Taxonomy Levels (BL): L1 – Remember, L2 – Understand, L3 – Apply, L4 –Analyze, L5 – Evaluate, L6 – Create

PO – Programme Outcome

| | | (5 × 15 = 75) | Marks | BL | CO | PO |
|---|---|---|---|---|---|---|
| I. | (a) | State second law of Thermodynamics according to Kelvin Plank and Claussius. Derive an equation for efficiency of heat engine and COP of refrigerator. | 5 | L2 | 1 | 1.4.1 |
| | (b) | State and prove Carnot theorem. | 5 | L2 | 1 | 1.4.1 |
| | (c) | Steam from a geothermal well is expanded in a Carnot cycle from a temperature of 150°C to 50°C. How much energy is extracted from 1 kg of steam? Find the efficiency. If the steam is heated to 250°C before expansion, how much energy is now extracted from 1 kg of steam in relation to the extra heat added and efficiency. Take specific heat of steam Cp = 1.9 KJ per kg per Kelvin. | 5 | L3 | 1 | 1.4.1 |
| | | **OR** | | | | |
| II. | (a) | Derive expressions for entropy changes in various thermodynamic processes. | 10 | L2 | 1 | 1.4.1 |
| | (b) | A refrigerator has a cooling effect of 156 KJ/KG and the work done by the compressor is 35 KW/KG. What is the COP of the refrigerator? If it works as a heat pump, what is its COP? | 5 | L3 | 1 | 1.4.1 |
| III. | (a) | What are the differences between water tube and fire tube boilers? | 5 | L1 | 2 | 1.4.1 |
| | (b) | Draw neat sketch of a La Monte boiler and explain its working. | 10 | L2 | 2 | 1.4.1 |
| | | **OR** | | | | |
| IV. | (a) | Draw PV, TS and HS diagrams for dry, wet and superheated steam for a simple Rankine cycle. | 5 | L1 | 2 | 1.4.1 |
| | (b) | A steam turbine receives dry saturated steam at 1 $MN/m^2$ and discharges at 0.1 $MN/m^2$. The steam flow rate is 3 kg/s and moisture at exit is negligible. If the ambient temperature is 30°C, find the rate of entropy production and power lost. | 10 | L2 | 2 | 1.4.1 |

(P.T.O.)

| | | | Marks | BL | CO | PO |
|---|---|---|---|---|---|---|
| V. | (a) | Explain different types of steam nozzles with sketches and its Mach number. | 5 | L2 | 3 | 3.1.1 |
| | (b) | What is the expression for critical pressure ratio? What is its significance? What is its value for dry and superheated steam? | 5 | L2 | 3 | 3.1.1 |
| | (c) | Explain supersaturated flow with the help of H-S diagram. | 5 | L2 | 3 | 3.1.1 |
| | | **OR** | | | | |
| VI. | (a) | Explain compounding of turbines. Explain pressure compounding of turbines with sketch. | 5 | L2 | 3 | 3.2.1 |
| | (b) | A single stage impulse turbine has the following data. Steam velocity 800 m/s, blade speed 300 m/s, nozzle angle 20°, blade outlet angle 25°. Neglecting friction, calculate the power developed by the turbine for a steam flow rate of 25 kg/s. Also calculate the axial thrust on bearings. | 10 | L2 | 3 | 3.2.1 |
| VII. | (a) | Differentiate between Otto and Diesel cycles. Draw the PV diagram for both. | 5 | L2 | 4 | 3.1.1 |
| | (b) | In an air standard Otto cycle, the pressure at the beginning and end of compression are 1 bar and 15 bar respectively. The maximum pressure is 30 bar. Determine (i) compression ratio (ii) Thermal efficiency. | 10 | L2 | 4 | 3.1.1 |
| | | **OR** | | | | |
| VIII. | (a) | Explain the following (i) Indicated power (ii) Brake power (iii) Friction power (iv) Mechanical efficiency (v) Thermal efficiency (vi) Volumetric efficiency. | 6 | L2 | 4 | 3.2.1 |
| | (b) | An oil engine working on a 4 stroke cycle gave the following results: Cylinder diameter 20 cm; stroke 40 cm, MEP 6bar, torque 407 N-m, speed 250 rpm, Oil consumption 4 kg/hr, Calorific value of oil 43 MJ/kg, cooling water flow rate 45 kg/min, air fuel ratio 30 kg, rise in cooling water temperature 45°C, temperature of exhaust gases 420°C, room temperature 20°C. Draw the heat balance sheet for the test in KJ/hr. Take Cp of exhaust gas 1 KJ/kgK. | 9 | L2 | 4 | 3.2.1 |
| IX. | (a) | Define Gibb's Dalton's law and Amagat's law of partial volume. | 7 | C | 5 | 4.1.1 |
| | (b) | Two vessels A and B both containing nitrogen are connected by a valve which is opened to allow both gases to mix and achieve an equilibrium temperature of 27°C. Before mixing the following information is known about the gases in the two vessels.<br>Vessel **A** p = 1.5 Mpa, t = $50^0$C, Content 0.5 kgmol<br>Vessel **B** p = 0.6 Mpa, t = $20^0$C, Content 2.5 kgmol<br>Calculate the final equilibrium pressure and the amount of heat transferred to the surroundings. Take Cp/Cv =1.4 | 8 | C | 5 | 4.1.1 |
| | | **OR** | | | | |
| X. | (a) | Define and explain Specific humidity, Relative humidity, dew point. | 7 | L2 | 5 | 4.1.1 |
| | (b) | A certain gas has Cp = 1.968 and Cv = 1.507 kJ/kgK find its molecular weight and gas constant. A constant volume vessel of 0.3 $m^3$ capacity contains 2 kg of this gas at temperature 5°C. Heat is transferred to the gas until the temperature is 100°C. Find the work done, the heat transferred and change in enthalpy, entropy and internal energy. | 8 | L2 | 5 | 4.1.1 |

Bloom's Taxonomy Levels
L1 – 7%, L2 – 86%, L3 – 7%

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