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# MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

*A Constituent Institution of Manipal University*

## III SEMESTER B.TECH. (INDUSTRAIL AND PRODUCTION ENGINEERING)

## END SEMESTER EXAMINATIONS, DEC 2016/JAN 2017

## SUBJECT: THERMAL ENGINEERING [MME 2113]

**REVISED CREDIT SYSTEM**
**(28/12/2016)**

Time: 3 Hours MAX. MARKS: 50

**Instructions to Candidates:**

- Answer **ALL** the questions.
- Missing data may be suitable assumed.
- Use of thermodynamic data book and steam table are permitted.

**1A.** Air is compressed in a frictionless steady flow process from 90 kPa, 15$^{o}$C and v = 0.918 m$^3$/kg to 130 kPa in such a manner that p (v+0.250) = constant where v is in m$^3$/kg. Inlet velocity is negligibly small and discharge velocity is 110 m/s. Calculate the work required per kg of air. **4**

**1B.** Define the following **3**

i. Intensive property
ii. Extensive property
iii. Quasistatic process

**1C.** Derive the steady flow energy equation with a neat diagram. **3**

**2A.** State Kelvin Planck and Clausius theorem of 2$^{nd}$ law of Thermodynamics with neat sketches. **4**

**2B.** Sketch and explain the Carnot cycle. **3**

**2C.** State and prove Clausius theorem on entropy. **3**

**3A.** Explain the working principle of air standard Otto cycle with neat sketch. **3**

**3B.** Air in a piston cylinder device of bore 200mm stroke 300mm and a clearance volume of 7% of stroke volume undergoes a diesel cycle. The pressure and temperature of air at the beginning of the compression are 1 bar and 27$^{0}$C. The maximum temperature in the cycle is 1900K. calculate the following (i) compression ratio and Cut off ratio (ii) cycle efficiency (iii) MEP **3**

**3C.** Explain Rankine cycle with a neat sketch and T-S diagram. **4**

**4A.** Derive an expression for the condition of minimum work of compression. **3**

**4B.** Explain Vapour compression refrigeration system with P-h diagram and cycle diagram. **4**

**4C.** An air refrigerating machine working on Bell-Coleman cycle takes in air into the compressor at 1 bar and **$-5^0$C**. It is compressed in the compressor to 5 bar and is cooled to $25^0$C at constant pressure. In the expander it is expanded to 1bar. The isentropic efficiency of the compressor and the expander are 85% and 90% respectively. Calculate **3**

(a) Refrigerating capacity of the system if the mass flow rate is 30kg/min
(b) Power required to run the compressor.
(c) COP

**5A.** With a neat sketch explain the working of a Bell Coleman cycle. **3**

**5B.** A reactor's wall is 320mm thick and made up of an inner layer of fire brick (k = 0.84 W/m$^o$C) covered with a layer of insulation (K = 0.16 W/m$^o$C). The reactor operates at 1325$^o$C and ambient temperature is 25$^o$C. determine **3**

(i) Thickness of the firebrick and insulation which gives minimum heat loss
(ii) Heat loss with insulating material has a maximum temperature of 1200$^o$C

**5C.** (i) Derive the expression for heat transfer in one dimension by conduction through a cylinder **4**

(ii) What is a white body and state Stephen Boltzman's law.