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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B. E. - Mechanical Engineering

Semester End Examination; July / August - 2022

Applied Thermodynamics

Time: 3 hrs *Max. Marks: 100*

Course Outcome's

The Students will be able to:

*CO1: **Apply** the basic knowledge of mathematics for Formulation and analysis of Random signals, Analog and Digital communication system.*

*CO2: Ability to **Analyze** various aspects of sampling, quantizing, encoding, Analog and Digital signal modulation/transmission and demodulation/reception techniques*

*CO3: **Articulate** the methods used for sampling, quantizing and **analyze** noise introduced in data transmission for designing a digital communication systems.*

*CO4: **Analyze** the error probabilities and SNR of various modulation schemes with the knowledge of random process.*

*CO5: **Apply** appropriate techniques, resources, and modern tools to **examine** and **design** elementary communication system for various modulation schemes and noise specification.*

***Note:** i) **PART-A** is compulsory. One question from each unit for maximum of 2 marks.*
*ii) **PART-B**: Answer any **TWO** sub questions (from a, b, c) from each unit for a Maximum of 18 marks.*

Q. No.	Questions	Marks
	I:PART -A	**10**
I a.	What is meant by mean effective pressure?	2
b.	Why a Carnot cycle is not used as a reference cycle for vapour power cycles? Give reasons.	2
c.	A one ton refrigerating machine works on reversed Carnot cycle. It requires 1.75 kW to maintain low evaporator temperature of 250°K. Find COP of refrigerator.	2
d.	What are the advantages of multi stage compression with intercooler?	2
e.	How friction power of an I.C. Engine can be determined using motoring test method?	2
	II:PART - B	**90**
	UNIT - I	**18**
1 a.	Derive an expression for the air standard efficiency of diesel cycle in terms of compression ratio, cutoff ratio and adiabatic index.	9
b.	The compression ratio of an air standard diesel cycle is 10. The condition at the beginning of compression is 101.325 KPa and 30°C. 750 kJ/kg of heat is added during constant pressure process. Determine; i) Maximum temperature and pressure ii) Mean effective pressure iii) The thermal efficiency of the cycle	9
c.	The air enters the compressor of an open cycle constant pressure gas turbine at a pressure of one bar and temperature of 20°C.The pressure of the air after compression is 4 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air fuel ratio used is 90:1. If flow rate of air is 3.0 kg/s find power developed and thermal efficiency of the cycle. Assume Cp = 1 kJ/kg°k, $\wp$ = 1.4 for air and gases, calorific value of fuel = 41800 kJ/kg.	9

Contd....2

UNIT- II **18**

2 a. Derive an expression for thermal efficiency of regenerative cycle with feed water (open type) heaters. 9

b. In a steam power plant operating on Rankine cycle, steam enters the turbine at 8 bar, 300°C. The condenser pressure is 0.1bar. Adiabatic efficiency of the turbine is 0.9. Calculate the thermal efficiency and the quality of steam at the exit of turbine. Neglect Pump work. Use extract of steam table given below. 9

Pin Bar	hf	h_{fg}	S_f	S_{fg}	V_f
	kJ/kg		kJ/kg.K		m^3/kg
0.1	191.8	2392.9	0.6493	7.502	0.001

P bar	300ºC
8	h_1=3057.3kJ/kg S_1=7.2348kJ/kg

c. A reheat Rankine cycle using water as the working fluid operates between the pressure limits of 10 kPa and 17500 kPa. Steam is super heated at 500°C. Before it is expanded to the reheat pressure of 4000KPa. Steam is reheated to a final temperature of 500°C. Determine;

i) The thermal efficiency of the cycle

ii) Steam rate use the extract of steam tables given below or use Mollier diagram (H-S diagram). 9

P in Kpa	S_f	S_{fg}	h_f	h_{fg}	V_f
	KJ/kg.K		kJ/kg		m^3/kg
10	0.6493	7.5	191.83	2392.9	0.001

	At 500ºC	
P in KPa	h kJ/kg	S kJ/kgºK
17500	3275.85	6.247
4000	3445	7.1

UNIT- III **18**

3 a. Define clearance ratio and derive an expression for the volumetric efficiency of a single stage air compressor in terms of pressure ratio and clearance ratio. 9

b. Air at 1 bar and 27°C is compressed to 7 bar by a single stage reciprocating compressor according to the law $PV^{1.3} = c$. The free air delivered was $1m^3$/min. Speed of the compressor 300 rpm. Stroke to bore ratio 1.5:1, mechanical efficiency 85% and motor transmission efficiency 90%. Determine Indicated power isothermal efficiency cylinder dimensions and power of the motor required to drive the compressor. 9

c. A multistage air compressor is to be designed to elevate the pressure from 1 bar to 125 bar such that stage pressure ratio will not exceed 4. Determine number of stages, exact stage pressure ratio and Intermediate pressures. 9

Contd….3

UNIT- IV **18**

4 a. With a neat sketch, explain vapour absorption refrigeration system including all the auxiliaries to improve its performance. 9

b. With the help of neat sketches (P-H diagram and T-S diagram), explain sub-cooling and super heating of vapour in a vapour compression refrigeration cycle. 9

c. A food storage chamber requires a refrigeration system of 1OT capacity with an evaporator temperature of −10°C and Condenser temperature of +30°C. The refrigerant F-12 is sub coded by 5°C before entering the throttle valve and the vapour is superheated by 6°C before entering the compressor. The specific heats of vapour and liquid are 0.7327 and 1.235. Determine; 9

i) Refrigerating effect/kg

ii) Mass of refrigerant circulated per/min

iii) COP

UNIT - V **18**

5 a. Explain Williams's line method and Morse Test method to determine Friction power. 9

b. In a test of 4-cylinder, 4 stroke petrol engine of 75 mm bore and 100 mm stroke the following results were obtained at full throttle at a constant speed and with a fixed setting of fuel supply at 0.082 kg/min and with BP with all 4 cylinders working = 15.24 kW, BP with cylinder No.1 cutoff= 10.45 kW BP with cylinder No.2 cutoff= 10.38 kW, BP with cylinder No.3 cutoff = 10.23 kW, BP with cylinder No. 4 cutoff = 10.45 kW. determine indicated power, indicated thermal efficiency, if the colorific value of the fuel = 44MJ/kg and relative efficiency based on IP if the clearance volume in each cylinder = 115 CC. 9

c. The following data were recorded during a test on single cylinder 4-stroke oil engine Bore =150 mm, stroke = 300 mm, speed = 18000 rph, Brake torque = 200 NM, IMep = 7 bar, fuel consumption = 204 kg/hr, cooling H_2O flow rate = 5 kg/min cooling H_2O temperature rise=30°C, air fuel ratio =22, exhaust gas temperature =410°C, specific heat of exhaust gases = 1.0 kJ/kg°C, Room Temperature = 20°C, Calorific value of fuel = 42 MJ/kg. Determine Mechanical efficiency, BSFC and draw the heat balance sheet on minute and percent basis. 9

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