Ref. No.: Ex/ME(M2)/PC/B/T/313/2025

BACHELOR OF ENGINEERING IN MECHANICAL ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION - 2025

Subject: INTERNAL COMBUSTION ENGINE

Time: 3 hours **Full Marks: 100**

(Any of the used symbols carries its usual meaning.)

ANSWER ANY FIVE QUESTIONS.

Q.1 (a) Explain the basic difference in the working principle of an internal combustion engine and an external combustion engine with examples. 2

(b) With a neat sketch of a vertical cross-section of a single cylinder spark-ignition engine, label the following components: 8
(i) piston, cylinder, and spark plug,
(ii) TDC, BDC, and stroke length,
(iii) crank shaft, crank and connecting rod,
(iv) carburetor, inlet and exhaust valves.

(c) Explain the working principle of a four-stroke spark ignition engine on a P-v diagram representing all its strokes and respective processes clearly, and hence, indicate the following on it: 6
(i) clearance volume, and
(ii) stroke volume

(d) Write briefly the basic differences between spark ignition (S.I.) engine and compression ignition (C.I.) engine? 4

Q.2 (a) Derive an expression for the thermal efficiency of Otto cycle in terms of the compression ratio (r_k) and ratio of specific heats (γ). 8

(b) An air-standard Dual cycle has a compression ratio of 10. The pressure and temperature at the beginning of compression are 1 bar and 27°C. The maximum pressure reached is 42 bar and the maximum temperature is 1500°C. Determine (i) temperature, pressure and volume at each node of the cycle, (ii) cut-off ratio, (iii) work done per kg of air and (iv) the cycle efficiency. Assume C_p = 1.005 kJ/kg.K and C_v = 0.718 kJ/kg.K for air. Plot the cycle on P-v and T-s planes. 12

Q.3 (a) Describe and indicate following losses on P-v diagram for an Otto cycle engine: 10
(i) losses due to variable specific heats
(ii) losses due to dissociation
(iii) losses due to spark advance
(iv) burning time losses
(v) incomplete combustion losses
(vi) exhaust blowdown losses

(b) What will be the effect on the efficiency of an Otto cycle having a compression ratio of 10, if C_v increases by 2%? 10

[Turn over

Q.4	(a)	With a neat sketch, present a typical valve timing diagram for a petrol engine, and write respective reasons behind such opening and closing of the valves.	5
	(b)	Define octane and cetane numbers.	3
	(c)	Calculate the diameter of fuel orifice of a four-stroke engine which develops 25 kW per cylinder at 2500 rpm. The specific fuel consumption is 0.3 kg/kW.hr. The fuel is injected at a pressure of 150 bar over a crank travel of 25°. The pressure in the combustion chamber is 40 bar. Coefficient of velocity is 0.875 and specific gravity is 0.8762.	12
Q.5	(a)	With a neat sketch and by labelling of all necessary components, explain briefly the working principle of a simple carburetor. Explain why a rich mixture is required in case of idling condition.	8
	(b)	A simple jet carburetor is required to supply 5 kg of air and 0.5 kg of fuel per minute. The fuel specific gravity is 0.75. The air is initially at 1 bar and 300 K. Calculate the throat diameter of the choke for a flow velocity of 100 m/s. Air velocity discharge coefficient is 0.8. If the pressure-drop across the fuel metering orifice is 0.80 of that of the choke, calculate orifice diameter assuming, $C_{df} = 0.60$ and $\gamma = 1.4$. Also find the air-fuel ratio.	12
Q.6	(a)	Briefly explain the stages of combustion in case of S.I. engines, and present each of the stages on the P-θ variation curve. Explain then the detonation phenomenon in case of S.I. engines.	8
	(c)	A petrol engine working on four-stroke develops a brake power of 20.9 kW. A Morse Test was conducted on this engine and the brake powers (kW) obtained when each cylinder was made inoperative by short circuiting the spark plug, are 14.9, 14.3, 14.8 and 14.5, respectively. The test was conducted at constant speed. Find the indicated power, mechanical efficiency and bmep when all the cylinders are firing. The bore of the engine is 75 mm and the stroke is 90 mm. The engine is running at 3000 rpm.	12
Q.7	(a)	With a neat sketch, explain the working of the fuel injection pump used in a C.I. engine. What is the purpose of providing helical grooves in the rotatable plunger?	10
	(b)	Draw the circuit diagram for the battery ignition system for an S. I. engine. Explain how the spark is produced.	10
Q.8		Write short notes on (any four):	5×4
	(a)	Compare Otto and Diesel cycles on P-v and T-s planes for same compression ratio and heat rejection.	
	(b)	Accelerating pump system/Economizer	
	(c)	Common rail injection system	
	(d)	Forced circulation cooling system	
	(e)	Morse test	
	(f)	Crankcase scavenged two stroke S. I. engine	