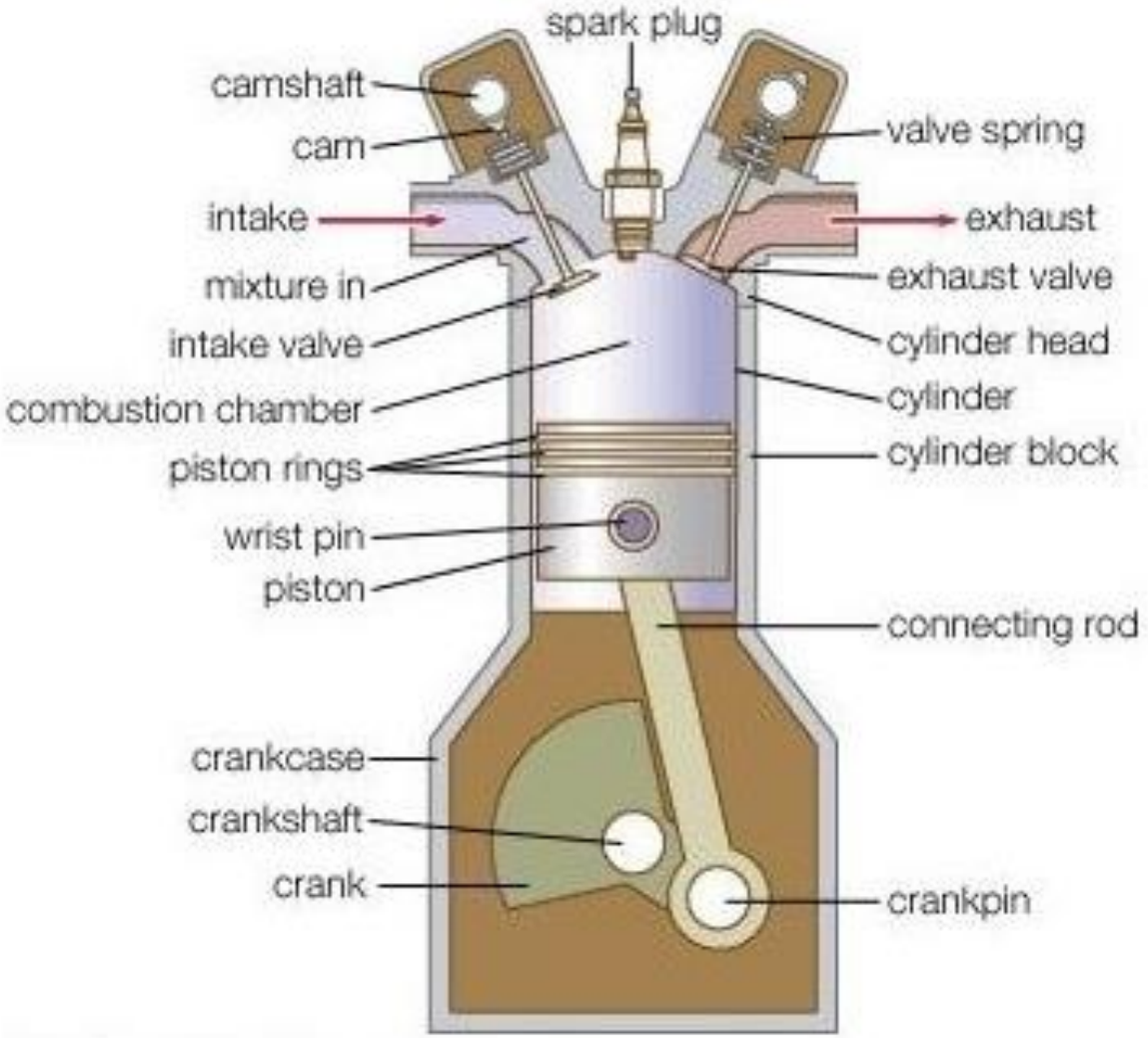
THERMAL ENGINEERING

Question Bank

II B.TECH- II SEMESTER **Regulation: R18**

ACADEMIC YEAR: 2019-20



FACULTY INCHARGE
Mr.R.SATHEESH
Asso.Prof.,
Dept. of Mechanical Engg.

PROGRAM OUTCOMES (PO's)

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

II B.Tech II Semester **L T P C**
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18MEC221 THERMAL ENGINEERING - I

Course Educational Objectives:

- **To acquire knowledge on analysis of stages in gas power cycles.**
- **To introduce the principles, working and various systems of IC engines.**
- **To analyze the combustion of SI engines and CI engines.**
- **To analyze the performance parameters of IC engines.**
- **To analyze the performance of air compressors.**

UNIT – 1: GAS POWER CYCLES

Otto, Diesel cycle analysis - MEP, efficiency calculations - Comparison of air standard and fuel-air cycles - Causes for deviation of fuel-air cycle from air standard cycle - Comparison of air standard and actual cycles - Time loss factor, head loss factors, blowdown loss and rubbing friction factors.

UNIT – 2: INTERNAL COMBUSTION ENGINES

Introduction of IC Engines: Classification of IC engines - Components and their function - Valve timing diagram and port timing diagram - Comparison of two stroke and four stroke engines, S.I and C.I engines. Fuel Systems: S.I. Engine: Carburetor - Mechanical and electrical fuel pump - C.I. Engine: Fuel injection pump - Fuel injector - Types of fuel injector nozzles. Cooling Systems: Cooling requirements - Air cooling and water cooling (thermosyphon and forced circulation system). Lubrication Systems: Petroil, splash, pressurized and mist lubrication. Ignition Systems: Function of an ignition system - Battery coil, magneto coil and electronic ignition system using contact breaker and contact triggers.

UNIT – 3: COMBUSTION IN IC ENGINES

S.I. Engine: Normal and abnormal combustion - Importance of flame speed and effect of engine variables - Type of abnormal combustion, pre ignition and knocking (concept only) - Fuel requirements and fuel rating, antiknock additives - Combustion chambers. C.I. Engine: Stages of combustion - Delay period and its importance - Effect of engine variables - Diesel knock - Combustion chambers - Fuel requirements and fuel rating.

UNIT – 4: TESTING AND PERFORMANCE OF IC ENGINES

Performance parameters - Measurement of cylinder pressure - Fuel consumption - Air intake - Exhaust gas composition - Brake power - Determination of frictional losses and indicated power - Performance test - Heat balance sheet.

UNIT – 5: AIR COMPRESSOR

Classification of air compressor - Reciprocating compressor - Workdone by single stage reciprocating air compressor with and without clearance volume - Efficiencies of reciprocating compressor - Multistage air compressor and inter cooling - Types of rotary air compressors (basics only) - Comparison between reciprocating and rotary air compressors.

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

Course Outcomes		POs related to COs
CO1	Acquire knowledge on gas power cycles and analysis on it.	PO1, PO2, PO3, PO4
CO2	Know the basic knowledge of an engine, identify the types, components of IC engines and explain the functions of each.	PO1
CO3	Demonstrate the basic knowledge and analyze the types and stages of combustion in SI and CI engines.	PO1
CO4	Investigation on IC engines for performance improvement and emission reduction to environment.	PO1, PO2, PO3, PO4, PO7
CO5	Demonstrate the basic knowledge of an air compressor in developing the analytical models.	PO1, PO2, PO3, PO4

Text Books:

1. Thermal Engineering, R.K Rajput, 8/e, Laxmi Publications (P) Ltd, New Delhi, 2010.
2. Internal Combustion Engines, V. Ganesan, 4/e, Tata McGraw-Hill Education Pvt. Ltd., Noida, 2012.

Reference Books:

1. IC Engines, Mathur and Sharma, 1/e, Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2010.
2. A course in thermal Engineering, C.P. Kothandaraman, S.Domkundwar and A.V.Domkundwar, 5/e, Dhanpat Rai & sons, 2002.
3. Thermal Engineering, Rudramoorthy, 15/e, Tata McGraw-Hill Education Pvt.Ltd, Noida, 2012.
4. I .C. Engines, Heywood, 1/e, Tata McGraw-Hill Education Pvt.Ltd., Noida, 1998.
5. Thermal Engineering, R.S.Khurmi and J.K.Gupta, 5/e, S Chand & Company Pvt. Ltd., New Delhi, 2008.

QUESTION BANK

Question No.	Questions	PO Attainment	BT
	UNIT 1 - GAS POWER CYCLES		
	PART-A (Two Marks Questions)		
1	What is thermodynamic cycle?	PO1	R
2	What are the assumptions made for air standard cycle analysis?	PO1	R
3	Mention the various thermodynamic processes in dual combustion cycle.	PO1	R
4	Define air standard cycle efficiency.	PO1	R
5	Name the factors that affect air standard efficiency of Diesel cycle	PO1	U
6	For the same compression ratio and heat supplied, state the order of decreasing air standard efficiency of Otto, Diesel and dual cycle.	PO1, PO2	U
7	What is the effect of cut-off ratio on the efficiency of diesel cycle when the compression ratio is kept constant?	PO1, PO2	U
8	Which cycle is more efficient with respect to the same compression ratio?	PO1, PO2	U
9	Define mean effective pressure as applied to gas power cycles.	PO1	R
10	Define the term compression ratio	PO1	R
11	Define the term cut off ratio.	PO1	R
12	How actual cycle does deviates from fuel-air cycle?	PO1, PO2	U
13	What is the effect of dissociation in the engine performance?	PO1	R
14	Write down mean effective pressure for Otto cycle?	PO1	R
15	Write down mean effective pressure for Diesel cycle?	PO1	R
16	Explain the term time loss factor?	PO1	R
17	Define the term head loss factor?	PO1	R
18	Briefly explain about blow down losses?	PO1	R
19	Explain rubbing friction factor?	PO1	R
20	Write the equation of air standard efficiency for diesel cycle with PV and TS diagram?	PO1, PO2	R
	PART-B (Ten Marks Questions)		
1	Derive the expression for air standard cycle and mean effective pressure in Otto cycle.	PO1, PO2, PO3	U
2	Derive the expression for air standard Diesel cycle.	PO1, PO2, PO3	U
3	Derive the expression for air standard dual combustion cycle.	PO1, PO2, PO3	U
4	Compare air standard cycle and actual cycle. Explain what are reasons for deviation and why?	PO1, PO2, PO4	U
5	In an Otto cycle air at 1bar and 290K is compressed isentropically until the pressure is 15bar. The heat is added at constant volume until the pressure rises to 40bar. Calculate the air standard efficiency and mean effective pressure for the cycle. Take C_v=0.717 kJ/kg K &R_{univ} = 8.314kJ/kg K	PO1, PO2, PO4	An
6	An engine of 250 mm bore and 375 mm stroke works on Otto cycle. The clearance volume is 0.00263 m^3. The initial pressure and temperature are 1 bar and 50°C. If the maximum pressure is limited to 25 bar, find the following: (i) the air standard efficiency of the cycle. (ii) the mean effective pressure for the cycle. Assume the ideal conditions.	PO1, PO2, PO4	An
7	The minimum pressure and temperature in an Otto cycle are 100 kPa and 27°C. The amount of heat added to the air per cycle is 1500 kJ/kg. (i) Determine the pressures and temperatures at all points of the air standard Otto cycle. (ii) Also calculate the specific work and thermal efficiency of the cycle for a compression ratio of 8: 1. Take for air: Cv = 0.72 kJ/kg K, and γ = 1.4.	PO1, PO2, PO4	An
8	Estimate the lose in air standard efficiency for the diesel engine for the compression ratio 14 and the cutoff changes from 6% to 13% of the stroke. The compression ratio of an air standard dual cycle is 12 and the maximum pressure on the cycle is limited to 70bar. The pressure and temperature of the cycle at the beginning of compression process are 1bar and 300K. Calculate the thermal efficiency and mean effective pressure. Assume cylinder bore=250mm, Stroke length=300mm, C_p=1.005kJ/Kg K, C_v=0.718kJ/Kg K.	PO1, PO2, PO4	An
9	Calculate the percentage loss in the ideal efficiency of a diesel engine with compression ratio 14 if the fuel cut-off is delayed from 5% to 8%.	PO1, PO2, PO4	An
10	A diesel engine operating an air standard diesel cycle has 20cm bore and 30cm stroke. The clearance volume is 420cm^3. If the fuel is injected at 5% of the stroke, find the air standard efficiency. Air enters the compressor of a gas turbine at 100 kPa and 25^{0}C. For a pressure ratio of 5 and a maximum temperature of 850°C. Determine the thermal efficiency using the Brayton cycle.	PO1, PO2, PO4	An

Question No.	Questions	PO Attainment	BT
	UNIT 2 –INTERNAL COMBUSTION ENGINES		
	PART-A (Two Marks Questions)		
1	List the various components of engine.	PO1	R
2	What is the function of camshaft and crank shaft?	PO1	R
3	Differentiate between SI and CI Engines?	PO1	R
4	Differentiate between 2- Stroke and 4-Stroke engines?	PO1	R
5	Draw valve timing diagram of SI engines with theoretical values.	PO1	U
6	Draw port timing diagram of CI engines with theoretical values.	PO1	U
7	What is meant by valve overlapping?	PO1	U
8	What do you mean by scavenging?	PO1	U
9	What are the various types and functions of piston rings?	PO1	R
10	What are the important elements of fuel feed system in SI engines?	PO1	R
11	Why choke is used in carburetor and what is meant by automatic chocking?	PO1	U
12	What are the various circuits in modern carburetor?	PO1	R
13	What is the purpose of providing spark plug in SI engine?	PO1	R
14	What are the important elements of fuel feed system in CI engines?	PO1	R
15	What are various types of cooling systems in IC engines?	PO1	R
16	What is the purpose of a thermostat in an engine cooling system?	PO1	R
17	What are various types of lubricating systems in IC engines?	PO1	R
18	What are various types of ignition systems in IC engines?	PO1	R
19	What is the function of contact breaker in ignition systems?	PO1	R
20	What is the function of ignition coil?	PO1	R
	PART-B (Ten Marks Questions)		
1	Classify the internal combustion engine.	PO1	R
2	Explain the construction and working of four stroke SI engine with a neat sketch.	PO1	R
3	Explain the construction and working of two stroke CI engine with a neat sketch.	PO1	R
4	Explain the construction and working of a mechanical fuel pump with a neat sketch.	PO1	R
5	Explain the working principle of simple carburetor with a neat sketch and mention the various limitations and how it is overcome?	PO1	R
6	Explain the construction and working of a fuel injection pump with a neat sketch and mention various types of fuel nozzles used in injector.	PO1	R
7	Explain why cooling is necessary in an I.C engine? With neat sketches describe the working of water cooling system used for multi-cylinder. Why should a pump and thermostat be provided in the cooling system of an engine?	PO1	R
8	Explain the pressure feed lubrication system with neat diagram?	PO1	R
9	With a neat diagram explain the working of battery ignition system.	PO1	R
10	Explain with suitable sketch the magneto-ignition system used in petrol engine and state its advantages and disadvantages over battery ignition-system system.	PO1	R

Question No.	Questions	PO Attainment	BT
	UNIT 3 – COMBUSTION IN IC ENGINES		
	PART-A (Two Marks Questions)		
1	What is meant by abnormal combustion in SI engine?	PO1	R
2	Define octane number?	PO1	R
3	Discuss the factors which promote pre-ignition?	PO1	R
4	What are the basic requirements of SI engine combustion chamber?	PO1	R
5	Name any two chemicals that can be used as additives in SI engine?	PO1	R
6	Describe the term knock rating of fuels.	PO1	U
7	How are the SI engine fuels rated? What do you understand by octane number-100?	PO1	U
8	Discuss about compression ratio and inlet temperature of mixture for operating variables on detonation.	PO1	R
9	How does detonation affect engine performance in SI engines?	PO1	R
10	Discuss about spark timing, engine speed and size of bore for operating variables on detonation.	PO1	R
11	Define cetane number?	PO1	R
12	Briefly explain the importance of flame speed on combustion?	PO1	R
13	What is the range of overall A/F ratio in a CI engine combustion chamber?	PO1	R
14	How do the injection timing and fuel quality affect the engine knock?	PO1	R
15	What is the role of ignition accelerators in CI engines, name one ignition accelerator?	PO1	R
16	How CI engine fuels are rated? Explain	PO1	R

17	Define swirl, squish and turbulence in CI engine	PO1	R
18	List out the advantages and disadvantages of non-turbulence combustion chamber?	PO1	R
19	List out the advantages and disadvantages of turbulence combustion chamber?	PO1	R
20	Enlist the various methods of controlling diesel knock?	PO1	R
	PART-B (Ten Marks Questions)		
1	What are the different stages of combustion in SI engines? How much heat is released in each stage?	PO1	U
2	What is abnormal combustion in SI engine? Compare the abnormal combustion with normal combustion by drawing suitable p-ɵ diagram?	PO1	U
3	Discuss the various factors that are to be considered in the design of S.I engine combustion chambers?	PO1	U
4	What are basic parameters that influence the flame speed? Discuss the influence of engine variables on the flame speed?	PO1	U
5	Explain the various types of combustion chambers used in SI engine?	PO1	U
6	Discuss the various stages of combustion in the CI engine?	PO1	U
7	What is meant by diesel knock and how to control? Explain with the help of example?	PO1	U
8	What are the various types of combustion chambers used in CI engine and state the advantage of each?	PO1	U
9	How to improve the fuel rating in C.I engine in order to avoid knocking in CI engine.	PO1	An
10	Explain the phenomenon of diesel knock in CI engines and compare the same with detonation in SI engine.	PO1	U

Question No.	Questions	PO Attainment	BT
	UNIT 4 – TESTING AND PERFORMANCE OF IC ENGINES		
	PART-A (Two Marks Questions)		
1	What are the various performance parameters in IC engines?	PO1	R
2	Define indicated power?	PO1	R
3	Define brake power?	PO1	R
4	Define frictional power?	PO1	R
5	What is meant by mean effective pressure	PO1	R
6	What is meant by indicated thermal efficiency?	PO1	R
7	What is meant by brake thermal efficiency?	PO1	R
8	What is meant by brake specific fuel consumption?	PO1	R
9	Define volumetric efficiency?	PO1	R
10	Define relative efficiency or efficiency ratio?	PO1	U
11	What is meant by heat balance sheet and what are the various items followed in it?	PO1	U
12	What are the various method involved to measurement of air consumption?	PO1	R
13	What is meant by dynamometer and how they are classified?	PO1	R
14	What is meant by Morse test in IC engine?	PO1	R
15	Why is Morse test conducted at constant speed?	PO1	U
16	What is meant by Willian's line method?	PO1, PO2	R
17	What is meant by motoring test?	PO1	R
18	How can we increase the efficiency of IC engine?	PO1, PO2	An
19	Why is higher compression more efficient?	PO1, PO2	An
20	What happens if engine compression is too high?	PO1, PO2	An
	PART-B (Ten Marks Questions)		
1	Define the following terms: a) mean effective pressure b) brake power c) indicated power d) brake specific fuel consumption e) brake thermal efficiency.	PO1	R
2	An automobile engine operates at a fuel air ratio of 0.05, volumetric efficiency of 90% and indicated thermal efficiency of 30%. Given that the calorific value of the fuel is 45 MJ/kg and the density of air at intake is 1 kg/m^3, determine the indicated mean effective pressure for the engine.	PO1, PO2, PO4	An
3	A 4 cylinder 4-stroke petrol engine having bore 6 cm and stroke 10 cm develops 65 N-m torque at 3000RPM. Find the fuel consumption of the engine in kg/hr and brake mean effective pressure, if the relative efficiency of 50% and clearance volume is 60 cm^3 take CV=40 MJ/Kg	PO1, PO2, PO4	An
4	A single cylinder oil engine has a compression ratio of 10 to 1. The specific fuel consumption is 0.6 kg/kW-hr, calorific value of the fuel oil is 44000 KJ/Kg. Calculate (a) indicated thermal efficiency and (b) relative efficiency. Assume the engine operate on the constant volume cycle and take γ=1.4 for air	PO1, PO2, PO4	An

5	A 6 cylinder, 4 stroke petrol engine consumes 0.4 kg/min fuel when running at 4000 RPM. Bore is 8 cm; Stroke is 10 cm. Clearance volume is 65 cm^3. The torque developed =150 N-m. Calculate BP, BMEP, $\eta_{brake\ thermal}$ and $\eta_{relative}$, CV=40 MJ/kg.	PO1, PO2, PO4	An
6	A four cylinder petrol engine has an output of 53kW at 2000rpm. A Morse test is carried out on the engine and torque readings of 1^{st} to 4^{th} cylinders are 176Nm, 171Nm, 168Nm and 173Nm respectively. The BSFC is 0.365kg/kW-hr. The heating value of fuel is 44.3MJ/kg. Calculate: (i) friction power, (ii) mechanical efficiency and (iii) thermal efficiency of the engine.	PO1, PO2, PO4	An
7	In a test with a 4-cylinder 4-stroke petrol engine the following results were obtained for a particular setting and speed. Brake power with all cylinders working with24 KW Brake power 1-cylinder cut off =16.2 KW Brake power 2-cylinder cut off =16.7 KW Brake power 3-cylinder cut off =16.8 KW Brake power 4-cylinder cut off =17.3 KW Estimate the I.P of engines and its Mechanical Efficiency?	PO1, PO2, PO4	An
8	A two stroke diesel engine was motored when meter reading was 1.5kW. Then the test on the engine was carried with following results: Brake torque = 120 N-m, RPM = 600; fuel used = 2.5 kg/hr, CV of fuel = 41 MJ/kg; cooling water used = 820 kg/hr., rise in cooling water temperature is 10^0C, exhaust gas temperature =350^0C; Room temperature = 25^0C; A: F = 32:1; calculate BP, IP, mechanical efficiency, indicated thermal efficiency and heat balance on percentage basis.	PO1, PO2, PO4	An
9	In a full load on an oil engine the following results were obtained. IP = 30kW, BP = 24 kW, Fuel consumption = 0.128 kg/min, Cylinder circulating = 5.9 kg/min, Temperature rise of cooling water = 49.5^0 C, Temperature of engine room = 18.4^0 C, Air to fuel ratio = 20, Calorific valve of oil = 45200kJ/kg, Specific heat of exhaust gas = 1.05 kJ/kg-K, Specific heat of water = 4.2 kJ/kg-K. Determine the mechanical and indicated thermal efficiencies and draw up an energy balance on the basis of kJ/min and in percentage.	PO1, PO2, PO3, PO4, PO7	An
10	A four stroke single cylinder oil engine the following observations will be recorded bore =300mm,Stroke=400mm, Speed=200r.p.m, Cycle=4-Stroke, Duration of trail =60min, Fuel consumption=7.05Kg, calorific value of fuel=44000KJ/kg, Area of indicated Diagram =322mm^2, Length of Indicated diagram =62mm, Spring index=1.1bar/mm, Net load on brakes =1324.35N, Brake drum Diameter=1600mm, Total mass of Jacket cooling water=495kg, Temperature rise of Jacket cooling water=38^0C, Temperature of exhaust gas =300^0C, Air consumption=311Kg. Assume specific heat of exhaust gas =1.004kJ/kg-K, specific heat of water= 4.186kJ/kg-K, Room Temperature =20^0C. Determine (i) Power available at brakes, (ii) Indicated power developed, (iii) Efficiency of mechanical, (iv) Thermal efficiencies and (v) Draw up for a heat balance sheet of trail.	PO1, PO2, PO4	An

Question No.	Questions	PO Attainment	BT
	UNIT 5 - AIR COMPRESSOR		
	PART-A (Two Marks Questions)		
1	Classify the various types of air compressors.	PO1	R
2	What is meant by single acting compressors?	PO1	R
3	What is meant by single stage compressor?	PO1	R
4	What is meant by double acting compressor?	PO1	R
5	Indicate the application of reciprocating compressors in industry?	PO1	A
6	What are the advantages of multi stage compression with internal cooling over single stage compression for the same pressure ratio?	PO1	U
7	What is meant by free air delivered?	PO1	R
8	Define the terms as applied to air compressors: volumetric efficiency and isothermal efficiency.	PO1	U
9	Define the mechanical efficiency and isothermal efficiency of a reciprocating air compressor.	PO1	U
10	Define clearance ratio?	PO1	R
11	Discuss the effect of clearance upon the performance of an air compressor.	PO1	U
12	Give two merits of rotary compressor over reciprocating compressor.	PO1	R
13	Name the methods adopted for increasing isothermal efficiency of reciprocating air compressor.	PO1	R
14	What is meant by inter cooler?	PO1	R
15	What are the factors that affect the volumetric efficiency of a reciprocating compressor?	PO1	U
16	What is compression ratio?	PO1	R
17	Draw the p-v diagram of a two stage reciprocating air compressor.	PO1	R
18	Give some example for positive displacement compressor.	PO1	A
19	What is the difference between complete or perfect inter cooling and incomplete or imperfect inter cooling.	PO1	U
20	How the rotary compressors are classified?	PO1	R
	PART-B (Ten Marks Questions)		
1	Derive an expression for the work done of single stage reciprocating air compressor without clearance volume.	PO1, PO2, PO3	An

2	Derive an expression for the volumetric efficiency of reciprocating air compressors with clearance and also derive at STP conditions.	PO1, PO2, PO3	An
3	A single stage double acting air compressor of 150kW power takes air in at 16 bar & delivers at 6 bar. The compression follows the law $PV^{1.35}=C$. The compressor runs at 160rpm with average piston speed of 150m/min. determine the size of the cylinder.	PO1, PO2, PO4	An
4	Air at 1 bar and 27^0C is taken into single stage single acting reciprocating air compressor with law of $PV^{1.1}=C$ to a final pressure of 7 bar and compression takes $1m^3$/min. Calculate the indicated power and isothermal efficiency. Also calculate the cylinder dimensions and power of motor required to drive compressor. Speed of the compressor is 5RPS, stroke to bore ratio is 1.5:1, η_{mech} = 85% and η_{trans} = 90%.	PO1, PO2, PO4	An
5	A 2kg/s of air enters the LP cylinder of two stage compressor. The overall pressure ratio is 9:1. The air at inlet to the compressor is 100kpa and 35^0C. The index of compression in each cylinder is 1.3. Find the inter cooler pressure for perfect inter cooling. Also find the minimum power required and percentage of power saved over single stage compression.	PO1, PO2, PO4	An
6	A single stage, double acting compressors has a free air delivery of $14m^3$/min, measured at 1.013bar and 15^0C. The pressure and temperature in the cylinder during induction are 0.95bar 15^0C. The delivery pressure is 7bar and index of compression and expansion is 1.3. Clearance volume is 5% of swept volume. Calculate (i) indicated power and (ii) volumetric efficiency.	PO1, PO2, PO4	An
7	A single stage single acting compressor delivers $15m^3$ of free air per minute from 1bar to 8bar. The speed of compressor is 300rpm. Assuming that compression and expansion follow the law $PV^{1.3}=C$ and clearance is $(1/16)^{th}$ of swept volume, find the diameter and stroke of the compressor. Take L/D=1.5. The temperature and pressure of air at the suction are same as atmospheric air.	PO1, PO2, PO4	An
8	A two stage singe acting air compressor compresses $2m^3$ airs from 1bar and 20°C to 15 bar. The air from the low pressure compressor is cooled to 25°C in the intercooler. Calculate the minimum power required to run the compressor if the compression follows $PV^{1.25}=C$ and the compressor runs at 400 rpm	PO1, PO2, PO4	An
9	A single stage, single acting air compressor is used to compress air from 1.013 bar and 25°C to 7 bar according to law $PV^{1.3}$ = C. The bore and stroke of a cylinder are 120mm and 150mm respectively. The compressor runs at 250 rpm. If clearance volume of the cylinder is 5% of stroke volume and the mechanical efficiency of the compressor is 85%, determine volumetric efficiency, power and mass of air delivered per minute.	PO1, PO2, PO4	An
10	A single acting, single stage air compressor has cylinder diameter 160mm and stroke length 300mm. It draws the air into its cylinder at a pressure of 100kPa at 27^0C. The air then compressed to a pressure of 650kPa. If the compressor runs at a speed of 2rev/s, determine a) Mass of air compressed per cycle, b) Work required per cycle and c) Power required to derive the compressor in kW. Assume the compression process follows PV = constant.	PO1, PO2, PO4	An

OBJECTIVE QUESTIONS
(From GATE, IES, NPTEL etc.,)

UNIT 1 - GAS POWER CYCLES

In an isolated system, _____ can be transferred between the system and its surrounding.
(a) only energy (b) only mass (c) both energy and mass (d) neither energy nor mass

Which of the following is an extensive property?
(a) Volume (b) Pressure (c) Viscosity (d) All of the above

The extensive properties of a system are _____
(a) independent of the mass of the system (b) depend upon temperature of the system
(c) depend upon the mass of the system (d) none of the above

If the temperature of intake air in internal combustion engine increases, then its efficiency will
(a) Remain same (b) Decrease (c) Increase (d) None of these

A cyclic heat engine does 50 kJ of work per cycle. If the efficiency of the heat engine is 75%, the heat rejected per cycle is
(a) $16\frac{2}{3}$ kJ (b) $33\frac{1}{3}$ kJ (c) $37\frac{1}{2}$ kJ (d) $66\frac{2}{3}$ kJ

A Carnot cycle is having an efficiency of 0.75. If the temperature of the high temperature reservoir is 727° C. What is the temperature of low temperature reservoir?
(a) 23°C (b) -23°C (c) 0°C (d) 250°C

An ideal air standard Otto cycle has a compression ratio of 8.5. If the ratio of the specific heats of (γ) is 1.4, then what is the thermal efficiency (in percentage) of the Otto cycle?
(a) 57.5 (b) 45.7 (c) 52.5 (d) 95

Consider air standard Otto and Diesel cycles, both having the same state of air at the start of compression. If the maximum pressure in both the cycles is the same, then compression ratio 'r' and the efficiency 'η' are related by
(a) $\eta_{Diesel} > \eta_{Otto}$ (b) $\eta_{Diesel} < \eta_{Otto}$ (c) $\eta_{Otto} = \eta_{Diesel}$ (d) $\eta_{Otto} = 0.5\eta_{Diesel}$

Three engines A, B and C operating on Carnot cycle use working substances as Argon, Oxygen and Air respectively. Which engine will have higher efficiency?
(a) Engine A (b) Engine B (c) Engine C (d) All engines have same efficiency

In a heat engine operating in a cycle between a source temperature of 606°C and a sink temperature of 20°C, what will be the least rate of heat rejection per kW net output of the engine?
(a) 0.50 kW (b) 0.667 kW (c) 1.5 kW (d) 0.0341 kW

For maximum specific output of a constant volume cycle (Otto cycle)
(a) The working fluid should be air (b) The speed should be high (c) Suction temperature should be high
(d) Temperature of the working fluid at the end of compression and expansion should be equal

The order of values of thermal efficiency of Otto, Diesel and Dual cycle, when they have equal compression ratio and heat rejection, is given by
(a) $\eta_{otto} > \eta_{diesel} > \eta_{dual}$ (b) $\eta_{diesel} > \eta_{otto} > \eta_{dual}$ (c) $\eta_{dual} > \eta_{otto} > \eta_{diesel}$ (d) $\eta_{otto} > \eta_{dual} > \eta_{diesel}$

A heat engine working on Carnot cycle receives heat at the rate of 40 kW from a source at 1200 K and rejects it to a sink at 300 K. The heat rejected is
(a) 30 kW (b) 20 kW (c) 10 kW (d) 5 kW

In the case of a Diesel cycle, increasing the cut-off ratio will increase
(a) Efficiency (b) mean effective pressure (c) The maximum weight (d) the engine weight

Comparison of Otto, diesel, and dual (limited-pressure) cycles

(Heat Engines)	(Cycles)
(A) Gas Turbine	1. Constant volume heat addition and constant volume heat rejection
(B) Petrol Engine	2. Constant pressure heat addition and constant volume heat rejection
(C) Stirling Engine	3. Constant pressure heat addition and constant pressure heat rejection
(D) Diesel Engine	4. Heat addition at constant volume followed by heat addition at constant temperature

Codes: A B C D
(a) 3 1 4 2 (b) 1 4 2 3 (c) 4 2 3 1 (d) 2 3 1 4

Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I (Cycles operating between fixed temperature limits)	List-II (Characteristic of cycle efficiency η)
A. Otto cycle	1. η depends only upon temperature limits
B. Diesel cycle	2. η depends only on pressure limits
C. Carnot cycle	3. η depends on volume compression ratio
D. Brayton cycle	4. η depends on cut-off ratio and volume compression ratio

Codes: A B C D
(a) 3 4 1 2 (b) 1 4 3 2 (c) 3 2 1 4 (d) 1 2 3 4

Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I	List-II
A. Air standard efficiency of Otto cycle	1. Mechanical efficiency
B. Morse test	2. Diesel cycle
C. Constant volume cycle	3. Brake thermal efficiency
D. Constant pressure heat addition	4. Otto cycle
	5. $1-\frac{1}{r^{(\gamma-1)}}$

Codes: A B C D
(a) 5 1 4 2 (b) 3 5 2 4 (c) 3 5 4 2 (d) 5 1 2 4

UNIT 2 - INTERNAL COMBUSTION ENGINES

The operation of forcing additional air under pressure in the engine cylinder is known as
(a) Scavenging (b) Turbulence (c) Supercharging (d) Pre-ignition

Knocking tendency in a S.I. engine reduces with increasing
(a) Compression ratio (b) wall temperature (c) Supercharging (d) engine speed

The air fuel ratio for idling speed of an automobile patrol engine is closer to
(a) **10: 1** **(b)15:1** **(c) 17 : 1** **(d) 21: 1**

At the time of starting, idling and low speed operation, the carburetor supplies a mixture which can be termed as
(a) Lean (b) slightly leaner than stoichiometric (c) stoichiometric (d) rich

(Autonomous)

DEPARTMENT of MECHANICAL ENGINEERING

QUESTION BANK (NBA & NAAC Accredited) THERMAL ENGINEERING-I (18MEC221)

Consider the following statements for a carburettor:
1. Acceleration jet is located just behind the throttle value 2. Idle jet is located close to the choke
3. Main jet alone supplies petrol at normal engine speeds
Which of the statements given above are correct?
(a) 1, 2 and 3 (b) 1 and 2 (c) 2 and 3 (d) 1 and 3

In some carburettor, meter rod and economiser device is used for
(a) Cold starting (b) idling (c) Power enrichment (d) acceleration

Where does mixing of fuel and air take place in case of diesel engine?
(a) Injection pump (b) Injector (c) Engine cylinder (d) Inlet manifold

_____is the ability of the oil to resist internal deformation due to mechanical stresses.
(a) Viscosity (b) Flash point (c) Fire point (d) None of the mentioned

The pressure, temperature and density of the mixture between the spark plug electrodes have a considerable influence on the _____ required to produce a spark.
(a) voltage (b) current (c) mass (d) none of the mentioned

In thermo-syphon system, the radiator should be kept well above the engine, to provide a height for natural circulation.
(a) True (b) False

The maximum temperature in the I.C. engine cylinder is of the order of
(a) 500°C -1000°C (b) 1000°C -1500°C (c) 1500°C -2000°C (d) 2000°C -2500°C

In compression ignition engines, swirl denotes a
(a) Haphazard motion of the gases in the chamber (b) Rotary motion of the gases in the chamber
(c) Radial motion of the gases in the chamber (d) None of the above

Match List I with List II and select the correct answer using the given code given below the lists:

List I (SI Engine Operational mode)		List II (A/F Ratio Supplied by the Carburetor)	
A.	Idling	1.	3
B.	Cruising	2.	10
C.	Maximum Power	3.	13
D.	Cold starting	4.	16
		5.	20

Codes: A B C D
(a) 2 4 5 1 (b) 4 5 3 2 (c) 2 4 3 1 (d) 4 5 3 1

Match List I (S.I. Engine Operational Mode) with List II (Air fuel Ratio by Mass) and select the correct answer:

List I		List II	
A.	Idling	1.	4: 1
B.	Cruising	2.	10: 1
C.	Maximum power	3.	12.5: 1
D.	Cold starting	4.	16: 1
		5.	14.8: 1

Codes: A B C D
(a) 2 4 3 1 (b) 5 4 1 3 (c) 2 3 5 1 (d) 5 3 1 4

UNIT 3 - COMBUSTION IN IC ENGINES

Alcohols are unsuitable as diesel engine fuels because
(a) The cetane number of alcohol fuels is very low which prevents their ignition by compression
(b) The cetane number of alcohol fuels is very high which prevents their ignition by compression
(c) The cetane number of alcohol fuels is very low which prevents their ignition by compression
(d) None of the above

What is the flash point of a liquid fuel?
(a) The temperature at which the fuel ignites spontaneously with a bang
(b) The temperature at which the fuel emits vapours at a rate which produces an inflammable mixture with air
(c) The temperature at which the fuel ignites with a clearly
(d) The temperature at which the fuel ignites without a spark

In a SI Engine, which one of the following is the correct order of the fuels with increasing detonation tendency?
(a) Paraffins, Olefins, Naphthenes, Aromatics (b) Aromatics, Naphthenes, Paraffins, Olefins
(c) Naphthenes, Olefins, Aromatics, Paraffins (d) Aromatics, Naphthenes, Olefins, Paraffins

The two reference fuels used for cetane rating are
(a) cetane and iso-octane (b) cetane and tetraethyl lead (c) cetane and n-heptane (d) cetane and α -methyl naphthalene.

Which one of the following is highly unsaturated?
(a) paraffin (b)olefin (c)naphthalene (d) aromatic

The degree of turbulence increases _____ with the piston speed.
a) indirectly b) directly c) linearly d) none of the mentioned

The flame propagation velocities range from
a) 10 to 15 m/s b) 15 to 70 m/s c) 20 to 80 m/s d) 30 to 90 m/s

Some of the important qualities of gasoline are
(a) volatility (b)sulphur content (c) both a and b (d) the above qualities are not applicable for gasoline engines

The abbreviation of TNT is
(a) tetra nitro toluene (b) tri nitro toluene (c)tri nitrous toluene (d) tetra nitrous toluene

The boiling points of various hydrocarbons increase with increase in molecular weight. True or false? Ans- True

The method for measuring volatility of SI engine fuels has been standardized by which of the following governing body?
(a) International Union for Pure and Applied Chemistry (IUPAC) (b) American Society for Testing Materials (ASTM)
(c) American Society of Mechanical Engineers (ASME) (d) Indian Oil Corporation Limited (IOCL)

Which of the following gas plays the key role in combustion of fuels?
(a) argon (b)oxygen (c) rubidium (d) rutherfordium

Which of the following factors are responsible for producing or preventing knock?
(a) temperature (b)pressure (c) density (d) all of the above

Knocking tendency is reducing at higher speeds. True or false? Ans- True

Why the bore of the SI engines are limited to 100 mm?
(a) it is difficult to manufacture the larger bore engines (b) for less tendency of knocking
(c) it increases the weight of vehicle which leads to low speeds of vehicle (d) none of the above

Which one of the engines of the same size has the less clearance volume?
(a) Otto engine (b) Diesel engine (c) Carnot engine (d) all engines have the same clearance volume

The probability of knocking in diesel engines is increased by
(a) High self-ignition temperature (b)Low volatility (c) Higher viscosity (d)All of these
Ans- d

Pour point of fuel oil is the
(a) Minimum temperature to which oil is heated in order to give off inflammable vapours in sufficient quantity to ignite momentarily when brought in contact with a flame
(b) Temperature at which it solidifies or congeals
(c) It catches fire without external aid
(d) Indicated by 90% distillation temperature i.e., when 90% of sample oil has distilled off

Which of the following factors increase detonation in the SI engine?
1. Increased spark advance.
2. Increased speed.
3. Increased air-fuel ratio beyond stoichiometric strength
4. Increased compression ratio.
Select the correct answer using the codes given below:
(a) 1 and 3 (b) 2 and 4 (c) 1, 2 and 4 (d) 1 and 4

Consider the following statements:
1. In the SI engines detonation occurs near the end of combustion whereas in CI engines knocking occurs near the beginning of combustion.
2. In SI engines no problems are encountered on account of pre-ignition.
3. Low inlet pressure and temperature reduce knocking tendency in SI engines but increase the knocking tendency in CI engines.
Which of the statements given above are correct?
(a) 1, 2 and 3 (b) Only 1 and 2 (c) Only 2 and 3 (d) Only 1 and 3

The tendency of petrol to detonate in terms of octane number is determined by comparison of fuel with which of the following?
(a) Iso-octane (b) Mixture of normal heptane & iso-octane (c) Alpha methyl naphthalene (d) Mixture of methane & ethane

UNIT 4 - TESTING AND PERFORMANCE OF IC ENGINES

With increasing temperature of intake air, IC engine efficiency
(a) Decreases (b) increases (c) Remains same (d) depends on other factors

Brake thermal efficiency of the three types of reciprocating engines commonly used in road vehicles are given in the increasing order as
(a) 2 stroke Sl engine, 4 stroke Sl engine, 4 stroke Cl engine (b) 2 stroke Sl engine, 4 stroke Cl engine, 4 stroke Sl engine
(c) 4 stroke Sl engine, 2 stroke SI engine, 4 stroke Cl engine (d) 4 stroke Cl engine, 4 stroke Sl engine, 2 stroke Sl engine

An automobile engine operates at a fuel air ratio of 0.05, volumetric efficiency of 90% and indicated thermal efficiency of 30%. Given that the calorific value of the fuel is 45 MJ/kg and the density of air at intake is 1 kg/m^3, the indicated mean effective pressure for the engine is
(a) 6.075 bar (b) 6.75 bar (c) 67.5 bar (d) 243 bar

In a variable speed S.I. engine, the maximum torque occurs at the maximum
(a) Speed (b) brake power (c) Indicated power (d) volumetric efficiency

The method of determination of indicated power of multi-cylinder SI engine is by the use of
(a) Morse test (b) Prony brake test (c) Motoring test (d) Heat balance test.

Willian's line test is used for determination of indicated power of the Otto engine. True or false? Ans – False

The units of calorific value is
(a) kJ/kg-k (b) MJ/kg-sec (c) kJ/kg (d) kW/min

An engine with 80 percent mechanical efficiency develops a brake power of 30 kW. The frictional power is 7.5 kW, the brake power at half load is 15 kW. What will be the indicated power? (Take bore =75mm, calorific value = 44MJ/Kg)
(a) 40.2 Watts (b) 0.402 kW (c) 37.5 kW (d) 0.375W

The engine which has the equal stroke length and the bore is known as
(a) Carnot engine (b) square engine (c) radial engine (d) cubical engine

The relative efficiency is always
(a) >1 (b) <1 (c) =1 (d) none of the above

What would be the mean piston speed of a diesel engine running at 1500 rpm and which has a bore of 100mm, L/d ratio of 1.5 and the compression ratio of 17?
(a) 6 m/s (b)7.5 m/s (c) 9.557 m/s (d) 15 m/s

The brake power will be greater than the indicated power in the diesel engines. True or false? Ans- False

The ratio of the area of the indicator diagram to the length of indicator diagram gives,
(a) indicated power (b) indicated thermal efficiency (c) mean piston speed (d) mean effective pressure

A 4 stroke CI engine with four cylinders develops indicated power of 125 kW and delivers a brake power of 100 kW. What would be the frictional power if compression ratio of the engine is 17.2?
(a) 25kW (b) 125.2 kW (c) 132.2kW (d) none of the above

The Carnot engine is used in which of the following sectors?
(a) aerospace and defence (b) automobiles (c) both a and b (d) none of these

UNIT 5 - AIR COMPRESSOR

The capacity of a compression is 10 m^3/minute.10 m^3/minute refers to.....
(a) Standard air (b) Free air (c) Compressed air (d) Compressed air at delivery pressure

The multi stage compression as compared to single stage compression.....
(a) Improves volumetric efficiency for the given pressure ratio (b) Reduces work done per kg of air
(c) Reduces cost of compressor (d) All of the above

Compression efficiency is compared against.....
(a) Ideal compression (b) adiabatic compression (c) Isentropic compression (d) Isothermal compression

The volume of air delivered by the compressor is called.....
(a) Free air delivery (b)Compressor capacity (c) Swept volume (d) None of the above

The most efficient method of compressing air is to compress it.....
(a) Isothermal (b) Adiabatically (c) Isentropically (d) Isochronically

Ratio of indicated HP and break HP is known as..... efficiency.
(a) Mechanical (b) Volumetric (c) Isothermal (d) Adiabatic

Maximum work is done in compressing air when the compression is.....
(a) Improves volumetric efficiency for the given pressure ratio (b) Isothermal (c)Adiabatic (d) Polytropic

The value of air sucked by the compressor during its suction stroke is called.....
(a) Free air delivery (b) Compressor capacity (c) Swept volume (d) none of the above

The maximum delivery pressure in a rotary air compression is.....
(a) 10 bar (b) 20 bar (c) 30 bar (d) 40 bar

The speed of the rotary compressor is.....as compared to reciprocating air compressor
(a) High (b) Low (c) Equal (d) None of the above

The overall isothermal efficiency of compressor is defined as the ratio of.....
(a) Isothermal HP to the bhp of motor (b) Power to drive compressor to isothermal hp
(c) Work to compress air isothermal to work for actual compression (d) none of these

The capacity of compression will be highest when its intake temperature is.....
(a) Lowest (b) Highest (c) Anything atmospheric (d) none of these

In an axial flow compressor the ratio of pressure in the rotor blades to the pressure rise in the compression in one stage.....
(a) What factor (b) Slip factor (c) Degree of reaction (d) Pressure coefficient

An air compressor may be controlled by.....
(a) Throttle control (b) Clearance control (c) Blow-off control (d) Any of the above

For a compressor least work will be done if the compression is .....
(a) Isentropic (b) Isothermal (c) Polytropic (d) None of these

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By
Mr.R.SATHEESH
Asso.Prof.,
Dept. of Mechanical Engg.,
SITAMS