I C ENGINES & COMPRESSORS

QUESTION BANK

UNIT –I

Actual Cycles and their Analysis: Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles Of CI Engines.

1. Draw the neat sketch of fuel pump for C.I Engine? Explain.
2. Explain the ideal and actual port timing diagrams of a 2-stroke S.I engine
3. Is the effect of compression ratio on efficiency as same in fuel-air also?
4. Explain with the help of p-v diagram the loss due to variation of specific heats in Otto cycle?
5. Briefly explain the operation of a piston controlled two stroke S.I. engine?
6. What is p-v diagram of an I.C. Engine? What is its imp ortance?
7. What is valve overlap in four stroke engine? Why it is provided?
8. Explain the principle of scavenging and its importance?
9. Illustrate the constructional details of an I.C engines? Explain briefly about imp ortant components?
10. How do you classify I.C. Engines? Explain in detail
11. Compare the actual cycles and fuel-air cycles of S.I Engine?
12. Mention various simplified assumptions used in fuel-air cycle analysis
13. Name the type of i.c. engines generally having valves and ports. How are these valves or ports operated.
14. Explain the working principle of wet sump lubrication with a sketch
15. What are the differences between air standard cycle and fuel-air cycle? Explain the significance of fuel-air cycle?
16. Why the actual cycle efficiency is much lower then the air standard cycle efficiency? The major losses in the actual engine
17. In an engine working on the diesel cycle air fuel ratio is 50:1. The temperature of air at the beginning of compression is 60^0 C and the compression ratio used is 14:1.what is ideal efficiency o f the engine? Calorific vale of fuel used is 42000 kJ/Kg , C_P =1.005 kJ/kg-K and C_V=0.717KJ/Kg-K for air .
18. What is the need and requirement of cooling in IC engines?
19. Explain the ideal & actual port timing diagrams of a 2-stroke S.I. engine.
20. Define volumetric efficiency and discuss the effect of various factors affecting the volumetric efficiency

UNIT-II

I.C. ENGINES : Classification - Working principles, Valve and Port Timing Diagrams, Air – Standard, air-fuel and actual cycles - Engine systems – Fuel, Carburetor, Fuel Injection System, Ignition, Cooling and Lubrication.

1. How the antiknock additives prevent detonation in S.I. Engine? What are different additives used in S.I. Engine?
2. What are homogeneous and heterogeneous mixtures? In which engines these mixtures are used? Explain.
3. What are generally faced problems in S.I. Engine combustion chamber? Iden- tify the suggestions to rectify the problems
4. What are different auxiliary components required in S.I. Engine for achieving better combustion. (Apr/May 2007)
5. What are different types of combustion chambers used in S.I.Engine?
6. Describe the mixture requirement in S.I. Engine for different speed conditions.How to achieve above requirements from the carburetor.
7. How are the injection system classified? Describe briefly why the air injection system is not used now a day.
8. What are different ill effects of knocking and suggest the methods to minimize knocking
9. How the mixture strength influence rate of burning and flame propagation speed?
10. Explain the phenomenon of flame propagation in S.I. Engine combustion.
11. What is pre-ignition? Discuss its ill effects on performance.
12. What is ignition lag in S.I. Engine combustion? Explain the influence of different operating parameters on ignition lag.
13. Clearly explain wet sump lubrication system with a sketch
14. Mention the various parameters which affect the engine heat transfer and explain their effect.
15. With neat sketches explain the working principle of simple carburetor
16. What is meant by crank case ventilation? Explain the details
17. Explain the important qualities of a good ignitions system
18. How are the injection system classified? Describe briefly why the air injection system is not used now a day?
19. What are the various components to be lubricated in an engine and explain how it is accomplished?
20. Briefly discuss the air-fuel ratio requirements of a petrol engine from no load to full load

UNIT – III

Combustion in S.I. Engines : Normal Combustion and abnormal combustion – Importance of flame speed and effect of engine variables – Type of Abnormal combustion, pre-ignition and knocking (explanation of) – Fuel requirements and fuel rating, anti knock additives – combustion chamber – requirements, types.

1. Explain the various factors that influence the flame speed.
2. What is delay period and what are the factors effecting the delay period?
3. What is meant by abnormal combustion? Explain the phenomenon of knock in S.I. engine
4. What is ignition lag in S.I. engine and how does it affect performance.
5. What are the various types of combustion chambers used in S.I. engines? Explain them briefly.
6. Describe the phenomenon of pre-ignition in S.I. engines and discuss its effect on the performance.
7. Briefly explain the stages of combustion in S.I. engines elaborating the flame front propagation
8. Explain with a neat sketch the battery ignition system.
9. Explain the effect of various engine variables on SI engine Knock
10. Describe the phenomenon of knocking in C.I. Engine and how it is different from S.I. Engine detonation.
11. What is the need of air movement in C.I. Engine combustion chamber? Explain.
12. Discuss the influence of parameters on diesel knock in C.I. Engine.
13. What are different four stages of combustion in C.I. Engine? Explain salient features.
14. How to minimize diesel knock? Explain different controlling methods
15. Explain the influence of turbulence and speed on delay period in C.I. Engine combustion
16. Draw the schematic diagram of Air cell combustion chamber and explain its working principle.
17. Draw p - θ diagram and explain different stages of combustion in C.I. Engines
18. How does detonation affect engine performance in SI engines
19. What are the various types of combustion chambers used in SI engines? Explain them briefly
20. Explain the phenomenon of knock in CI engines and compare it with SI engine knock

UNIT IV

Combustion in C.I. Engines : Four stages of combustion – Delay period and its importance – Effect of engine variables – Diesel Knock– Need for air movement, suction, compression and combustion induced turbulence – open and divided combustion chambers and nozzles used – fuel requirements and fuel rating.

1. What is the purpose of engine testing?
2. List the parameters by which performance of an engine is evaluated.
3. Explain the details of the analytical method of performance estimation.
4. Define Scavenging efficiency? Explain its significance.
5. Explain the various engine performance parameters in detail.
6. Explain the principle of prony brake and rope brake in measuring engine power
7. What are two general types of combustion chamber used in CI engines? Describe the process of mixing fuel and air in these chambers?
8. The factors that promote knock in CI engine reduce knock in SI engine .Explain and discuss the statement.
9. what are the different methods used in CI engines to Create turbulence in the mixture ? Explain its effect on power output and thermal efficiency of the engine
10. Discuss the advantages and disadvantages of the two types of combustion chambers of CI engines.
11. Explain with figure air cell combustion chamber
12. With figures explain open combustion chambers.
13. What are the effects of the following variables on the diesel knock.
    (i) Injection timing and rate of fuel the injection.
    (ii) Turbulence caused in the combustion chamber
    (iii) Compression ratio.
14. A six cylinder, four stroke cycle marine oil engine has cylinder diameters of 610 mm and a piston stroke of 1250 mm. When the engine speed is 120 rpm it uses 340 kg of fuel oil of calorific value 44.2 MJ / kg in one hour. The cooling water amounts to 19200 kg / h, entering at 15^{o}C and leaving at 63^{o}C. The torque transmitted at the engine couplings is 108 k N-m and the indicated mean effective pressure is 775 kPa. Determine
    (a) the ip, (b) the bp,
    (c) the mechanical efficiency, (d) bmep
    (e) brake thermal efficiency
    (f) the percentage of energy supplied per kg of fuel lost to the cooling water, (g) the fuel used per kWh on a brake power basis.
15. A four stroke diesel engine consumes 4.3 kg of fuel per hour when running at

600 rpm. The engine dimensions are 100 mm bore and 160 mm stroke. If the spring height is 4.5 mm with spring index of 1 bar/mm. Calculate IP, BP, mechanical efficiency and brake thermal efficiency if CV of fuel is 44000 kJ/kg.

16. A four-stroke cycle automobile engine is tested while running at 3600 rpm. Inlet air temperature is 16^0C and the pressure is101.36 kN/m . The engine has eight in-line cylinders with a total piston displacement of 4066 cc. The air fuel ratio is 14 and the bsfc is 0.377 kg/kWh. Dynamometer readings show a power output of 86 kW. Find the volumetric efficiency.

17. Find the bore of the single-cylinder diesel engine working on the four-stroke cycle and delivers 40 kW at 200 rpm from the following data:

Compression ratio: 14:1

Fuel cut-off: 5% of stroke

Index of compression curve: 1.4

Index for expansion curve: 1.3

Pressure at beginning of compression: 1 atm

Ratio of stroke to bore: 1.5 to 1.

18. The following date was recorded during testing of a four stroke cycle gas engine. Area of indicator diagram =

900 mm^2; Length of indicator diagram = 70 mm; spring scale = 0.3 bar/mm; Diameter of piston = 200 mm; Length of stroke = 250 mm; Speed = 300 rpm. Determine

i. Indicated mean effective pressure

ii. Indicated power.

UNIT – V

Testing and Performance: Parameters of performance - 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 and chart.

1. What is the influence of intake temperature, intake pressure, clearance and compression and expansion indices on the performance of reciprocating air compressor?
2. Explain the use of prong brake and rope brake in measuring the power output of an engine.
3. A four stroke gas engine having a cylinder of 250mm diameter and stroke 450 mm has a volumetric efficiency of 80%, ratio of air to gas is 8: 1, and calorific value of gas is 20MJ/m^3 at NTP. Find the heat supplied to the engine per working cycle. If the compression ratio is 5, what is the heating value of the mixture per working stroke per m^3 of total cylinder volume?
4. Explain the principle involved in the measurement of brake power
5. Explain the method of measurement of smoke?
6. Describe the methods of finding friction power using morse test.

8. Explain the following as referred to air compressors. (i) Isothermal efficiency, (ii) Volumetric efficiency

9. Describe the methods of finding friction power using Morse test

10. What is the significance of conducting the Morse Test? Explain in detail.

11. Schematically explain the use of the study of the heat balance of an engine

12. A single acting two stage compressor with complete inter cooling delivers 6 kg/min of air at 16 bar. Assuming an intake at 1 bar and 150C and compression and expansion with the law $pV^{1.3} = C$. Calculate.

(a) Power required running the compressor at 420 rpm

(b) Isothermal efficiency

(c) Free air delivered per sec.

13. Explain the effect of the following factors on the performance of an SI engine:
i) compression ratio ii) air-fuel ratio iii) spark timing iv) Engine speed.

14. A 6 cylinder gasoline engine operates on the 4-stroke cycle. The bore of the each cylinder is 80mm and the stroke is 100 mm.

The clearance volume per cylinder is 70 cm^3. At a speed of 400 rpm the fuel consumption is 20 kg/h and the torque developed is 150 N-m. Calculate.

(i)Brake power

(ii)Brake mean effective pressure

(iii)Brake thermal efficiency. If the calorific value of the fuel is 43000 KJ/kg

15. Explain the use of prony brake and rope brake in measuring the power output of an engine.

16. A four stroke gas engine having a cylinder of 250mm diameter and stroke 450 mm has a volumetric efficiency of 80%, ratio of air to gas is 8: 1, and calorific value of gas is $20MJ/m^3$ at NTP. Find the heat supplied to the engine per working cycle. If the compression ratio is 5, what is the heating value of the mixture per working stroke per m^3 of total cylinder volume?

17. An air compressor takes in air at 1 bar (100 kPa) and 20^0C and compresses it according to the law pV^{12} = constant. It is then delivered to a receiver at a constant pressure of 10 bar (1000 kPa). Determine

(a) The temperature at the end of compression and

(b) The heat transferred and work done during the compression process per kg of air

(c) The work done during delivery. Take $R = 287$ **J** / kg K and $\gamma = 1.4$.

18. A single acting air compressor draws in 5 m^3 / min of air at 1 bar and 20^0C and delivers it at 8 bar. The compression follows the law $pV^{1.35} = C$. Neglect clearance. Compare the indicated power required if the following methods are adopted.

(a) Single stage compression.

(b) Two stage compression with best intercooler pressure and perfect intercooling.

(c) Two stage compression with the same intercooler pressure as in (b) but the cooling is not perfect and the temperature of intercooled air can be brought to 25^0 C.

(d) Three stage compression with perfect intercooling. Assume R = 287 J / kg K.

19. The average indicator and information taken from a 25 × 35 cm, single cylinder, double- acting reciprocating air compressor operating at 80 r.p.m is

Head end area = 11.1 cm^2, Crank end area = 12.9 cm^2, Length = 7.5 cm, spring scale = 2.5 bar per cm of deflection. Account for the 5 cm diameter piston rod and find

(a) Then mean effective pressure and the indicated

power for each end; (b) The total indicated power

UNIT – VI

COMPRESSORS – Classification –positive displacement and roto dynamic machinery – Power producing and power absorbs machines, fan, blower and compressor – positive displacement and dynamic types – reciprocating and rotary types.

Reciprocating: Principle of operation, work required, Isothermal efficiency volumetric efficiency and effect of clearance, stage compression, undercooling, saving of work, minimum work condition for stage compression.

1. What is surging in axial-flow compressors? What are its effects? Describe briefly
2. What is stalling in an axial compressor stage? How is it developed?
3. What is rotating stall? Explain briefly the development of small and large stall cells in an axial compressor stage
4. A single-sided centrifugal compressor is to deliver 15 kg of air per second when operating at a pressure ratio of 4 : 1 and a speed 12,000 r.p.m. The inlet stagnation conditions may be taken as 288 K and 100 K pa. Assuming a slip factor of 0.9, a power and input factor of 1.04 and an isentropic efficiency of 80%, estimate the overall diameter of the impeller. If the Mach number is not to exceed unity at the impeller tip, and 50% of the losses are assumed to occur in the impeller, find the minimum possible depth of the diffuser.
5. A centrifugal compressor has an impeller tip speed of 366 m/s. Calculate the absolute Mach Number of the flow leaving the radial vanes of the impeller when the radial component of velocity at impeller exit is 30.5 m/s and slip factor is 0.90.Given that the mass flow area at impeller exit is 0.1 m2 and the total efficiency of the impeller is 90%, determine the mass flow rate.

6. Air at a temperature of 290 K enters a ten stage axial flow compressor, at the rate of 3.0 kg/s. The pressure ratio is 6.5 and the isentropic efficiency is 90 per cent, the compression process being adiabatic. The compressor has symmetrical stages. The axial velocity of 110 m/s is uniform across the stage and the mean blade speed of each stage is 180 m/s. Determine the direction of the air at entry to and exit from the rotor and the stator blades and also the power given to the air. $C_p = 1.005$ KJ/kg K and $\gamma = 1.4$.

7. List the various types of rotary compressors?

8. Explain with a neat sketch, the working of a roots blower

9. Under what circumstances would you recommend the use of multistage compressor?

10. Explain with a neat sketch, the working of a vane blower?

11. With the help of neat sketches explain a Roots Air Blower. How its p-v diagram is different from a reciprocating air compressor

12. Draw typical velocity profiles at the impeller exit from hub-to-tip and vane-to-vane.

13. Describe with a neat sketch the construction and working of a single stage single acting Reciprocating air compressor

14. Compare reciprocating and rotary air compressors.

15. A single acting compressor has zero clearance, stroke of 200 mm and piston diameter 150 mm. when the compressor is operating at 250 rpm and compressing air from $10 N/cm^2$, 25^0 to $40 N/c^2$ find.

i) The volume of air handled ii) the ideal power required

16. Determine the work done per revolution in driving the compressor when

i) Ports are so placed that no internal compression takes place as in case of Roots Blower

ii) The ports are so placed that there is 50% pressure rise due to internal adiabatic compression before back flow occurs. Also determine the efficiency in both cases.

17. Explain the terms slip factor and power input factor in centrifugal compressors

18. A centrifugal compressor operating at a pressure ratio of 4:1 has inlet temperature of 15^oC. Calculate the overall diameter of impeller given that speed of operation 15000 rpm.

Slip factor 0.9

Power input factor 1.03

Isentropic efficiency 0.85

19. A multistage axial flow compressor with equal work done per stage and same velocity of flow throughout the compressor has the following data :

Overall stagnation pressure ratio = 4

Stagnation inlet temperature $=50^0$ C Relative air angle at rotor inlet $= 130^0$

Relative air angle at rotor outlet	$= 100^0$
Blade velocity	= 200 m/sec
Degree of reaction	= 0.5
Overall stagnation adiabatic efficiency	= 0.85

The data refer to mean blade height and the measurement of angle is done in the same sense from the blade velocity diagram, Calculate

(a) Stagnation outlet temperature
(b) Number of stages.

20. A single-sided straight vaned centrifugal compressor is required to deliver 10 kg of air per sec with a total pressure ratio of 4 : 1 when operating at a speed of 16,500 r.p.m. The air inlet pressure and temperature are 1.013 bar and 300 K. Calculate:

(a) Actual rise in stagnation temperature
(b) Tip speed of the impeller
(c) Tip diameter
(d) Inlet eye annulus area and
(e) Theoretical power required to drive the compressor.

Take $\sigma = 0.94$, $\eta_c = 80$ percent, $c_p = 1.005$ kJ/kg K, $\gamma = 1.4$, The air enters the eye axially with a velocity of 150 m/s.