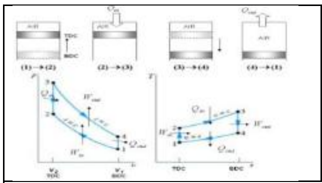	Course Title : **Heat Power Engineering** Credits (L:T:P) : 4**:0:0** Type of course: : **Lectures**	Course Code**: 15AT31T** Core/ Elective: **Core** Total Contact Hours: **52**
25 Marks		**100 Marks**

Prerequisites:

Basic knowledge of Science, Maths & Automobile Engg-1.

Course Objectives:

The course should enable the students to:

1. Analyse different thermodynamic process and cycles.
2. Explain the testing process of fuel and estimate the calorific value of given fuel.
3. Analyse the combustion process of fuel and estimate air required for complete combustion.
4. Differentiate the combustion process in SI and CI engines.

On successful completion of the course, the students will be able to attain CO:

Course Outcome		**CL**	**Linked PO**	**Teaching Hrs**
CO1	Understand the fundamentals of thermodynamics and laws of thermodynamics to solve related problems.	***R/U/A***	1,2,3,6	09
CO2	Understand different laws and equations related to perfect gas to find solutions to related problems.	***R/U/A***	1,2,3	**08**
CO3	Understand different thermodynamic process with related equations and graphs to find solutions for related problems	***R/U/A***	1,2,3	**10**
CO4	Explain different thermodynamic cycles and solve related problems	***U/A***	1,2,3	**10**
C05	Compare different types of fuels, Understanding the need, types, structure, combustion process and production of fuels.	***U/A***	1,2,3,6	**08**
CO6	Understand and compare combustion process in SI and CI engines.	U/A	1,2,3,6	07
		Total sessions		**52**

COURSE-PO ATTAINMENT MATRIX

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Heat power Engineering	**3**	**3**	**3**			**3**				

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.

If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3

If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2

If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1

If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

COURSE CONTENT AND BLUE PRINT OF MARKS FOR SEE

Unit No	Unit Name	Hour	Questions to be set			Marks weightage (%)
			R	U	A	
I	Fundamentals And Laws Of Thermodynamics	9	**05**	**10**	**10**	**17.3**
II	Laws Of Perfect Gases.	8	**05**	**05**	**10**	**13.8**
III	Thermodynamic Processes On Gases.	10	**05**	**05**	**20**	**20.6**
IV	Air Standard Cycles.	10	**05**	**05**	**20**	**20.6**
V	Fuels And Combustion.	8	**05**	**05**	**10**	**13.8**
VI	Combustion In SI And CI Engines.	7	**05**	**10**	**05**	**13.8**
	Total	**52**	**145**			**100**

Legend: R; Remember, U: Understand A: Application

Course Delivery: The course will be delivered through lectures, presentations and classroom discussions.

Course Content:

UNIT I

Fundamentals and Laws of Thermodynamics 9hrs

Introduction to thermodynamics- system- boundary - surrounding, Types of thermodynamic systems – closed, open and isolated systems with examples, Properties of system- Intensive and Extensive properties with examples, thermodynamic state-process-cycle, point and path functions, thermodynamic equilibrium – mechanical – chemical - thermal, quasi static process, basic thermodynamic properties- pressure - Volume - Temperature –Energy-potential energy-kinetic energy-internal energy -heat- Specific heat at constant pressure-specific heat at constant volume-work- Enthalpy -Entropy and their units, standard atmospheric conditions-NTP-STP.

Laws of thermodynamics: -Zeroth- first-second, simple problems on conversion of Heat into Work and vice versa.

UNIT II

Laws of perfect gases 8hrs

Definition of perfect gas, Gas Laws – Boyle's law - Charles's Law – Gay-Lussac law - Avogadro's law-Joule's law, characteristic gas equation- universal gas equation, universal gas constant and their relationship with molecular weight of gas, Derivation for an expression showing the relationship between the two specific heats- characteristic gas constant R-Adiabatic index ϒ, Simple problems.

UNIT III

Thermodynamic processes on gases 10hrs

Introduction to thermodynamic processes, derive expressions for PVT relations-work done-heat transfer-change in internal energy-change in enthalpy and entropy for Constant volume, Constant pressure, Isothermal, Isentropic processes, Simple problems on the above processes.

UNIT IV

Air standard cycles 10hrs

Air standard cycles- definitions and types, assumptions made in air standard cycles

Description - P.V. and T-S diagrams of Carnot cycle, Otto cycle, diesel cycle, dual combustion cycle

Derivation of air standard efficiency of Carnot cycle, Otto cycle, diesel cycle, dual combustion cycle, Simple problems.

UNIT V

Fuels and Combustion 8hrs

Fuels-types of fuel-solid fuel-liquid fuel-gaseous fuel with merits and demerits, refining process of crude oil-products of refining process, structure of petroleum, definition of heat values – higher heat value and lower heat value, calorimeter-types-bomb calorimeter-Junkers calorimeter, SI engine fuel-requirements-rating - octane number, CI engine fuel-requirements - rating - cetane number, fuel additives, simple problems to find HCV and LCV on Bomb and Junkers calorimeter.

Combustion-Definition-main combustible elements-atomic mass-molecular mass, combustion equations by mass –by volume, equation for minimum oxygen/air required for complete combustion, conversion of gravimetric (mass) analysis into volumetric analysis, excess air supplied, Flue gas analysis using Orsat apparatus, Simple problems to find minimum air quantity-mass analysis-volumetric conversion-excess air.

UNIT VI

Combustion in SI and CI engines. 7hrs

SI engine: Stages of combustion with pressure crank angle diagram, ignition lag-variables affecting ignition lag, detonation- definition – process- effects – controlling method, surface ignition- wild ping –rumble- run on-run away, pre-ignition.
CI engine: Stages of combustion with pressure crank angle diagram, ignition delay -variables affecting delay period, knocking- definition – process- effects – controlling method.

Resources:

Reference books:

SINO	Title of the book	Author	Publisher
1	Thermal Engineering	R.S.Khurmi	S Chand & Co
2	Thermal Engineering	R K Hegde and Niranjan.Murthy	Sapna Publications
3	Basic and applied thermodynamics	P.K.Nag	Tata MCgraw-Hill
4	I C Engines	Mathur &Sharma	Danapat Rai & sons
5	I C Engines	V. Ganeshan	Tata MCgraw-Hill

Websites:

- https://www.youtube.com/watch?v=9GMBpZZtjXM
- https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8
- https://www.youtube.com/watch?v=xQwi9fveGTQ&index=2&list=PLD8E646BAB3366BC8
- https://www.youtube.com/watch?v=sUDfpFD0xX4&index=4&list=PLD8E646BAB3366BC8
- https://www.youtube.com/watch?v=-42JmVBdlM4
- https://www.youtube.com/watch?v=lbPEaaKiCww
- https://www.youtube.com/watch?v=gg-dlrbXxzI
- https://www.youtube.com/watch?v=Xto88gMmDzw
- https://www.youtube.com/watch?v=7ZpuMBkf1Ss
- https://www.youtube.com/watch?v=0Oq7bCSDPxE
- https://www.youtube.com/watch?v=pucd2b7jZJw
- https://www.youtube.com/watch?v=K8RzTmeVWfM
- https://www.youtube.com/watch?v=fyadfj7NQqI
- https://www.youtube.com/watch?v=YNGtJo-VspE
- https://www.youtube.com/watch?v=NG41IbDtd44
- https://www.youtube.com/watch?v=HeofLEQ6wuA
- https://www.youtube.com/watch?v=-FpRVaZhTlE
- https://www.youtube.com/watch?v=W94iksaQwUo
- https://www.youtube.com/watch?v=ZWKRw0HmBLE

Student Activities to be performed to award five marks in continuous internal evaluation:

1. Prepare a report on applications of Laws of Thermodynamics.
2. Prepare a report on different issues related to fuels like additives, price hikes, pollution norms, health and environmental effects.
3. Collect special features of combustion chambers used in engines of different vehicles to reduce pollution, noise, vibration and harshness levels.

Note:

1. **Student should prepare a report on any one of the above/similar activity, which helps in achieving above course outcomes.**
2. **The report prepared should be approved by the concerned staff and HOD.**
3. **The activity group should consist of maximum of three students.**

MODEL OF RUBRICS FOR ASSESSING STUDENT ACTIVITY:

Note: The Dimensions given in below table are only representative. The lecturer has to design/decide suitable dimensions based on the activity given.

Dimension	Scale					Students Score				
	Unsatisfactory 1marks	Developing 2marks	Satisfactory 3marks	Good 4 marks	Exemplary 5marks	1	2	3	4	5
1. Research and gather information	Does not collect information relate to topic	Collects very limited information, some relate to topic	Collects basic information, most refer to the topic	Collects more information, most refer to the topic	Collects a great deals of information, all refer to the topic	2				
2.Full fills teams roles and duties	Does not perform any duties assigned to the team role	Performs very little duties	Performs nearly all duties	Performs almost all duties	Performs all duties of assigned team roles	3				
3.Shares work equally	Always relies on others to do the work	Rarely does the assigned work, often needs reminding	Usually does the assigned work, rarely needs reminding	Always does the assigned work, rarely needs reminding.	Always does the assigned work, without needing reminding	4				
4. listen to other team mates	Is always talking, never allows anyone to else to speak	Usually does most of the talking, rarely allows others to speak	Listens, but sometimes talk too much,	Listens and talks a little more than needed.	Listens and talks a fare amount	5				
Grand Average/Total=(2+3+4+5)/4=14/4=3.5=4						4				

Course Assessment and Evaluation Scheme:

Method	What		To whom	When/Where (Frequency in the course)	Max Marks	Evidence collected	Course outcomes
Direct Assessment	CIE (Continuous Internal Evaluation)	IA	Students	Three IA Tests; (Average of three Tests)	20	Blue books	1,2,3,4,5,6
				Activity	05	Activity report	1,2,3,4,5,6
	SEE (Semester End Examination)	End Exam		End of the course	100	Answer scripts at BTE	1,2,3,4,5,6
Indirect Assessment	Student Feedback on course		Students	Middle of the course		Feedback forms	1,2 &3Delivery of course
	End of Course Survey			End of the course		Questionnaires	1,2,3,4,5,6 Effectiveness of Delivery of instructions & Assessment Methods

***CIE** – Continuous Internal Evaluation *SEE – Semester End Examination

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

FORMAT OF I A TEST QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6^{th} weak of sem 10-11 Am	I/II SEM		20
	Year:		

Name of Course coordinator : Units:__
CO's:____

Question no	Question	MARKS	CL	CO	PO
1					
2					
3					
4					

Note: Internal choice may be given in each CO at the same cognitive level (CL).

MODEL QUESTION PAPER (CIE)

Note to Course co-coordinator: The course coordinator has to fallow the question paper blue print given in above table

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6 th week of sem 10-11 Am	III semester	Heat power Engineering	20
	Year: 2015-16	Course code:15AT31T	

Name of Course coordinator : Units:1,2 Co: 1,2

Note: Answer all questions

Question no	Question	CL	CO	PO
1	Define the following terms. 5marks a. System b. State c. Process d. cycle e. Property	R	1	1,2,10
2	Explain Zeroth law of thermo dynamics 5marks or Explain first law of thermodynamics for cyclic process. 5marks	U	1	3,10
3	A vessel of capacity 3 m^3 contains air at a pressure of 1.5 bar and a temperature of 25^0 C. Additional air is now pumped into the system until the pressure rises to 30 bar and temperature rises to 60^0 C. Determine the mass of air pumped in and express the quantity as a volume at a pressure of 1.02 bar and a temperature of 20^0 C. 10marks or The values of specific heats at constant volume and constant pressure of an ideal gas are 0.73 KJ/Kg K and 0.98 KJ/Kg K respectively. Find the value of characteristic gas constant. If one Kg of this gas heated at constant pressure from 25^0 C to 200^0 C, estimate heat added, work done and change in internal energy. 10marks	A	2	1,2,10

Legend: R; Remember, U: Understand A: Application

MODEL QUESTION BANK

CO1: Understand the fundamentals of thermodynamics and laws of thermodynamics to solve related problems.

FIVE MARKS QUESTIONS

1. Define a thermodynamic system and mention its different types. (R)
2. Distinguish between an open and closed system. (A)
3. What do you mean by property of a system? Distinguish extensive and intensive properties of a system. (R/A)
4. Define the following terms. (R)

a. System b. State c. Process d. cycle e. Property

5. Distinguish between mechanical and thermal equilibrium. (A)

6. Distinguish between work and heat. (A)
7. Define the following properties. (R)
   a. Pressure b. Volume c. Temperature d. Density e. Specific volume
8. Define Temperature. Name the different temperature scales in common use. (R)
9. Establish relation between Celsius and Fahrenheit scales. (A)
10. What is absolute temperature? (R)
11. Differentiate between gauge and absolute pressure. (A)
12. What do you understand by STP and NTP? What are their values? (R)
13. With reference to heat explain the following. (U)
    a. Direction of heat b. Sign convention
14. Define point function and path function. (R)
15. Prove that heat is a path function. (A)
16. Define energy. What is stored energy and transit energy?(R)
17. Discus the different types of stored energy. (A)
18. Explain Zeroth law of thermodynamics. (U)
19. Explain the first law of thermodynamics for a cyclic process. (U)
20. Write Kelvin Planck and Clausius statements of second law of thermodynamics. R/U)
21. The pressure of a steam inside a boiler, as measured by pressure gauge is 1 N/mm^2. The barometric pressure of the atmosphere is 765 mm of mercury. Find the absolute pressure of steam in N/m^2, Kpa, bar and N/mm^2. (A)
22. In a condenser of a steam power plant the vacuum is recorded as 700 mm of mercury. If the barometer reading is 760 mm of mercury, find the absolute pressure in the condenser in $N/m^{2,}$ Kpa, bar and N/mm^2. (A)

TEN MARKS QUESTIONS

---------------NILL-------------

CO2: Understand different laws and equations related to perfect gas to find solutions to related problems.

FIVE MARKS QUESTIONS

1. What is a perfect gas? Under what conditions does a real gas behave as a perfect gas?(R/A)
2. Name the variables that control the physical properties of a perfect gas. (R)
3. State Boyle's law and Charles's law. (R)
4. State Gay-Lussac's law, Joule's law and Avogadro's law. (R)
5. Derive an expression for General gas equation. (U)
6. Derive an expression for Characteristic equation of a perfect gas. (U)
7. What is difference between universal gas constant and characteristic gas constant? (A)
8. Define specific heat at constant volume and at constant pressure. (R)
9. What is an adiabatic index? Why its value is greater than unity? (R?A)

10. A gas occupies a volume of $0.1m^3$ at a temperature of 20^0C and a pressure of 1.5 bars. Find the final temperature of the gas, if it is compressed to a pressure of 7.5 bar and occupies a volume of $0.04m^3$. (A)
11. A gas at temperature of 333^0 C and 20 bars has a volume of 0.06 m^3. It is expanded to volume of 0.54 m^3. Determine the final pressure of the gas, if the final temperature of the gas after expansion is 30^0 C. (A)

TEN MARKS QUESTIONS

1. Prove that the difference between two specific heats (C_p and C_v) is equal to characteristic gas constant"R". (A)
2. A vessel of capacity 3 m^3 contains air at a pressure of 1.5 bar and a temperature of 25^0 C. Additional air is now pumped into the system until the pressure rises to 30 bar and temperature rises to 60^0 C. Determine the mass of air pumped in and express the quantity as a volume at a pressure of 1.02 bar and a temperature of 20^0 C. (A)
3. A mass of 2.25 kg of nitrogen occupying 1.5 m^3 is heated from 25^0 C to 200^0 C at a constant volume. Calculate the initial and final pressures of the gas. Take universal gas constant as 8314 J/Kg mol K. The molecular mass of nitrogen is 28. (A)
4. A closed vessel contains 2 Kg of carbon dioxide at temperature 20^0 C and pressure 0.7 bar. Heat is supplied to the vessel till the gas occupies a pressure of 1.4 bar. Calculate final temperature, work done on or by the gas, heat added and change in internal energy. Take specific heat at constant volume as 0.657 KJ/Kg K. (A)

5. The values of specific heats at constant volume and constant pressure of an ideal gas are 0.73 KJ/Kg K and 0.98 KJ/Kg K respectively. Find the value of characteristic gas constant. If one Kg of this gas heated at constant pressure from 25^0 C to 200^0 C, estimate heat added, work done and change in internal energy. (A)

CO3:Understand different thermodynamic process with related equations and graphs to find solutions for related problems

FIVE MARKS QUESTIONS

1. What do you understand by a thermodynamic process? Distinguish between reversible and irreversible process. (R/A)
2. Derive an expression for the work done during an isothermal process. (U)
3. Derive an expression for the work done during and the adiabatic expansion of an ideal gas. (U)
4. Derive an expression for the work done during isobaric process. (U)
5. Derive an expression for the change in internal energy during isochoric process. (U)
6. Derive an expression for the heat supplied or heat rejected during isochoric process.(U)
7. Derive an expression for the change in enthalpy during isochoric process. (U)
8. Derive an expression for the change in internal energy during isobaric process. (U)

9. Derive an expression for the heat supplied or heat rejected during isobaric process.(U)
10. Derive an expression for the change in enthalpy during isobaric process. (U)
11. Derive an expression for the change in internal energy during isothermal process. (U)
12. Derive an expression for the heat supplied or heat rejected during isothermal process.(U)
13. Derive an expression for the change in enthalpy during isothermal process. (U)
14. Derive an expression for the change in internal energy during isentropic process. (U)
15. Derive an expression for the heat supplied or heat rejected during isentropic process.(U)
16. Derive an expression for the change in enthalpy during isentropic process. (U)
17. Represent constant volume process on p-v diagram and p-T diagram. (R/U)
18. Represent constant pressure process on p-v diagram and p-T diagram. (R/U)
19. Represent constant temperature process on p-v diagram and p-T diagram. (R/U)
20. Represent adiabatic process on p-v diagram and p-T diagram. (R/U)

TEN MARKS QUESTIONS

1. A certain gas occupies a space of $0.3m^3$ at a pressure of 2 bar and a temperature of 77^0 C. It is heated at constant volume until the pressure is 7 bars. Determine temperature at the end of process, mass of the gas, change in internal energy and change in enthalpy during the process. Assume C_p = 1.005 KJ/Kg K; C_v = 0.712 KJ/Kg K and R= 287 J/Kg K. (A)
2. The values of specific heat at constant pressure and at constant volume for an ideal gas are 0.984 KJ/Kg K and 0.728 KJ/Kg K. find the values of characteristic gas constant and ratio of specific heats for the gas. If one kg of this gas is heated at constant pressure from 25^0 C to 200^0 C, estimate the heat added, work done and change in internal energy. Also calculate the pressure and final volume, if the initial volume was 2 m^3. (A)
3. 0.1 m^3 of air at a pressure of 1.5 bars is expanded isothermally to 0.5 m^3. Calculate the final pressure of the gas and heat supplied during the process. (A)
4. The initial volume of 0.18 kg of a certain gas was 0.15 m^3 at a temperature of 15^0 C and a pressure of 1 bar. After adiabatic compression to 0.05 m^3, the pressure was found to be 4 bars. Find Gas constant, Molecular mass of the gas, Ratio of the specific heats, two specific heats and Change in internal energy. (A)

5. A system contains 0.15 m^3 of a gas at a pressure of 3.8 bar and 150^0 C. It is expanded adiabatically till the pressure falls to 1 bar. The gas then heated at a constant pressure till its enthalpy increases by 70 KJ. Determine the total work done. Take C_p= 1 KJ/Kg K and C_v = 0.714 KJ/Kg K (A)

CO4:Explain different thermodynamic cycles and solve related problems

FIVE MARKS QUESTIONS

1. What is a thermodynamic cycle? State clearly the assumptions made. (R/A)
2. Classify Air standard cycles. (A)

3. Represent Carnot cycle on p-v and T- s diagram. (R)
4. Represent Otto cycle on p-v and T- s diagram. (R)
5. Represent Diesel cycle on p-v and T- s diagram. (R)
6. Represent Dual combustion cycle on p-v and T- s diagram. (R)
7. For a given compression ratio the air standard diesel cycle is less efficient than air standard Otto cycle. Explain. (A)
8. A Carnot engine working between 650K and 310 K produces 150KJ of work. Find thermal efficiency and heat added during the process. (A)
9. In an engine working on Otto cycle and using ideal air as the working substance has its compression ratio raised from 5 to 6, Find out percent increase in efficiency. (A)
10. Calculate the ideal efficiency of an engine working on diesel cycle when the compression ratio is 15 and cut off ratio is 2.5. (A)
11. Show for same compression ratio of 6 the efficiency of the diesel cycle is less than the Otto cycle. Take $\gamma = 1.4$ and $\rho = 2.5$. (A)

TEN MARKS QUESTIONS

1. Explain with p-v and T-s diagram the working of Carnot cycle. (U)
2. Explain with p-v and T-s diagram the working of Otto cycle. (U)
3. Explain with p-v and T-s diagram the working of Diesel cycle. (U)
4. Explain with p-v and T-s diagram the working of Dual combustion cycle. (U)
5. Derive an expression for air standard efficiency of Carnot cycle. (U)
6. Derive an expression for air standard efficiency of Otto cycle. (U)
7. Derive an expression for air standard efficiency of Diesel cycle. (U)
8. Derive an expression for air standard efficiency of Dual combustion cycle. (U)
9. A Carnot engine operates between two reservoirs at temperatures T_1 and T_3. The work output of the engine is 0.6 times the heat rejected. The difference in temperatures between the source and sink is 200^0 C. Calculate the thermal efficiency, source temperature and the sink temperature. (A)
10. An engine, working on the Otto cycle, has a cylinder diameter of 150mm and a stroke of 225mm. The clearance volume is 1.25×10^{-3} m^3. Find the air standard efficiency of this engine. Take $\gamma = 1.4$. (A)
11. In an ideal Diesel cycle, the temperatures at the beginning and end of compression are 57^0 C and 603^0 C respectively. The temperatures at the beginning and of expansion are 1950^0 C and 870^0 C respectively. Determine the ideal efficiency of the cycle. Take $\gamma = 1.4$. If the compression ratio is 14 and the pressure at the beginning of the compression is 1 bar calculate the maximum pressure in the cycle. (A)
12. An oil engine, working on dual combustion cycle has a compression ratio 10 and cut off takes place at $1/10^{th}$ of the stroke. If the pressure at the beginning of compression is 1 bar and maximum pressure 40 bars, determine the air standard efficiency of the cycle.
    Take $\gamma = 1.4$ (A)

CO5:Compare different types of fules, Understanding the need,types,structure, combustion process and production of fuels.

FIVE MARKS QUESTIONS

1. Define fuel and state chief combustible elements of fuel. (R)
2. Define and explain Calorific value of fuel. (R)
3. Differentiate between HCV and LCV of a fuel and which is used in practical calculation and why? (A)
4. A fuel consists of 85% carbon; 12.5% hydrogen; 2.5% residual matter by mass. Working from first principles, find the higher and lower calorific values per kg of the fuel. (A)
5. Calculate the minimum mass of air required for complete combustion. (A)
6. Explain the conversion of Volumetric analysis into mass analysis. (U)
7. Explain the conversion of mass analysis into volumetric analysis. (U)
8. What do you understand by 'minimum air' and 'excess air' in context of combustion?(U)
9. Give chemical reactions and numerical values for estimating the air requirement for complete combustion of fuel. (R/U)
10. A sample of coal gas has the following composition by mass; carbon 75%; hydrogen 6%; oxygen 8%; nitrogen 2.5%; sulphur 1.5%; and ash 7%. Calculate its higher and lower calorific values per kg of coal. (A)

TEN MARKS QUESTIONS

1. What are the methods used for finding the calorific value of fuel and explain any one method with a neat sketch. (U)
2. Explain how calorific value of a fuel is calculated with Bomb's calorimeter. (U)
3. Explain how calorific value of a fuel is calculated with Junker's calorimeter. (U)
4. Explain how flue gas analysis is made using Orsat apparatus. (U)
5. The volumetric composition of a gaseous fuel is given by H_2 = 27%, CO = 7%, CH_4 = 48%, C_2H_4 = 13%, CO_2 = 3%, and N_2 =2%. Determine the minimum quantity of air required for burning of one m^3 of fuel. (A)
6. The volumetric analysis of gas is CO_2 14%, CO 1%, O_2 5% and N_2 80%. Calculate the fuel composition by mass. (A)
7. A fuel gas the following percentage composition by mass: CO_2 13.3%, CO 0.95%, O_2 8.35% and N_2 77.4%. Convert this into volumetric analysis. (A)
8. Calculate the higher calorific value of a coal specimen from the following data;

Mass of coal burnt	= 1kg
Quantity of water in calorimeter	= 2.5kg
Increase in temperature of water	=2.6^0 C
Water equivalent of apparatus	=390gm

If the fuel used contains 6% of hydrogen, calculate its lower calorific value. (A)

CO6:Understand and compare combustion process in SI and CI engines.

FIVE MARKS QUESTIONS

1. Define Ignition lag. Mention the variables affecting ignition lag. (R)
2. Explain the phenomenon of knocking in SI engine. (U)
3. Explain the phenomenon of Detonation in CI engine. (U)
4. What are the effects of knocking in SI engine? (A)
5. What are the effects of knocking in CI engine? (A)
6. Which are the controlling methods of detonation in SI engine? (R)
7. Which are the controlling methods of detonation in CI engine? (R)
8. Define delay period. Mention variables affecting delay period. (R)
9. What do you mean by Pre-ignition? Explain. (R/U)

TEN MARKS QUESTIONS

1. With the help of p-ɵ diagram, explain the stages of combustion in SI engine. (U)
2. With the help of p-ɵ diagram, explain the stages of combustion in CI engine. (U)
3. Discus the effect of the following engine variables on knocking in SI engine. (A)
   a. Delay period b. Temperature c. Compression d. Mixture quality.
4. Discus the effect of the following engine variables on knocking in CI engine. (A)

a. Delay period b. Temperature c. Compression d. Mixture quality

5. Explain the following surface ignition phenomenon (U)
   a. Wild ping b. Rumble c. Run-on d. Run-away.

BOARD OF TECHNICAL EXAMINATION

MODEL QUESTION PAPER

HEAT POWER ENGINEERING

Max Marks: 100 **Time: 3 Hr**

Note: **1.** Answer any **six** questions from **PART-A** and each question carries **five** marks.

2. Answer any **seven** questions from **PART-B** and each question carries **ten** marks.

PART-A

1. Define point function and path function.
2. Write Kelvin Planck and Clausius statements of second law of thermodynamics.
3. Explain the zeroth law of thermodynamics in cyclic process.
4. State Boyle's law and Charles law.

5. Explain the difference between universal gas constant and characteristic gas constant.
6. Represent constant volume process on p-v diagram and p-T diagram.
7. Derive an expression for work done during isobaric process.
8. State the assumptions made in explaining the Air standard cycles.
9. Represent Carnot cycle on PV and TS diaphragm.

PART-B

1. The pressure of a steam inside a boiler, as measured by pressure gauge is 1 N/mm^2. The barometric pressure of the atmosphere is 765 mm of mercury. Find the absolute pressure of steam in N/m^2, kPa, bar and N/mm^2.
2. Prove that the difference between two specific heats (C_p and C_v) is equal to characteristic gas constant(R).
3. A certain gas occupies a space of $0.3m^3$ at a pressure of 2 bars and a temperature of 77^0 C. It is heated at constant volume until the pressure is 7 bars. Determine temperature at the end of process, mass of the gas, change in internal energy and change in enthalpy during the process. Assume C_p = 1.005 KJ/Kg K; C_v = 0.712 KJ/Kg K and R= 287 J/Kg K.
4. A system contains 0.15 m^3 of a gas at a pressure of 3.8 bar and 150^0 C. It is expanded adiabatically till the pressure falls to 1 bar. The gas then heated at a constant pressure till its enthalpy increases by 70 KJ. Determine the total work done. Take C_p= 1 KJ/Kg K and C_v = 0.714 KJ/Kg K.
5. An engine, working on the Otto cycle, has a cylinder diameter of 150mm and a stroke of 225mm. The clearance volume is $1.25x10^{-3}$ m^3. Find the air standard efficiency of this engine. Take γ = 1.4.
6. A Carnot engine operates between two reservoirs at temperatures T_1 and T_3. The work output of the engine is 0.6 times the heat rejected. The difference in temperatures between the source and sink is 200^0 C. Calculate the thermal efficiency, source temperature and the sink temperature.

7. a) Define HCV and LCV. 5marks
   b) Explain the process of conversion of volumetric analysis into mass analysis. 5marks
8. The volumetric composition of a gaseous fuel is given by H_2 = 27%, CO = 7%, CH_4 = 48%, C_2H_4 = 13%, CO_2 = 3%, and N_2 =2%. Determine the minimum quantity of air required for burning of one m^3 of fuel.
9. With the help of p-ɵ diagram, explain the stages of combustion in CI engine.
10. a) Define ignition lag and mention the variables affecting it. 5marks
    b) What are the effects of Knocking in SI engine? 5marks