UNIT 61: ENGINEERING THERMODYNAMICS

Unit code: D/601/1410QCF   level: 5   Credit value: 15

ASSIGNMENT 2.1 INTERNAL COMBUSTION ENGINES.

Assignment front sheet to be attached to assignment when submitted for assessment.

NAME:

You are allowed a maximum of 4 weeks from the date of issue to complete this assignment.

Date Issued   Date submitted

I agree to the assessment as contained in this assignment. I confirm that the work submitted is my own work.

Signed

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:	Achieved
L02 Be able to evaluate the performance of internal combustion engines	2.1 apply the second law of thermodynamics to the operation of heat engines	
	2.2 evaluate theoretical heat engine cycles	
	2.3 evaluate the performance characteristics of spark ignition and compression ignition internal combustion engines	
	2.4 discuss methods used to improve the efficiency of internal combustion engines	
MERIT	• use a range of methods and techniques to collect, analyse and process information/data. • Apply and analyse detailed knowledge and skills, using relevant theories and techniques. • Coherently present and communicate work using technical language correctly.	
DISTINCTION	• Check validity when collecting, analysing and processing complex information/data. • Evaluate and synthesise relevant theories and techniques to generate and justify valid conclusions. • Show an individual approach in representing and communication work coherently, using technical language fluently.	

Feedback Comments

Brief I,V. by   Date   IV

Grade Awarded   Tutor Signature   Date

In this assignment you are expected to produce a report with four sections as explained below. You should use correct technical language throughout. Remember that to get a grade better than a pass you need to show some depth of research and comprehension of the topics. You should attach information found from other sources and name these sources. You have 4 weeks to complete the work.

PART 1 THEORETICAL CYCLES

OTTO CYCLE

The theoretical cycle for a spark ignition engine is the Otto cycle. In this section you will study how the compression ratio affects the maximum pressure, temperature and efficiency.

- ***Explain the four thermodynamic processes used in the Otto cycle.***
- ***Sketch the p – V diagram and T – s diagrams to help with your explanations.***

This is the relevant information needed. Point (1) of the Otto cycle is at the start of the compression stroke. The temperature and pressure at this point are respectively 10 ^{o}C and 1 bar. The heat input at constant volume is 100 kJ per kg of air.

Write out the formula for the following as a function of the compression ratio (r_v) and the known constants of the cycle.

- ***The air standard efficiency of the Otto cycle*** η.
- ***The temperature at the end of the compression stroke (T_2).***
- ***The temperature after heating (T_3)***
- ***The pressure after heating (p3)***
- ***The temperature after the expansion stroke (T_4)***

GRAPHS

- **For compression ratios r_v of 2 to 20, determine η, T_2, T_3, p_3 and T_4.**
- **Plot T_2, T_3 and T_4 gainst r_v on one graph**
- **Plot η against r_v.**

You are strongly recommended to use a software package such as Matchcad. You must show your calculations in full with all the formula clearly identified. Study the resulting graphs and analyse them.

CARNOT CYCLE

- ***Explain why no heat engine can be 100% efficient.***
- ***Explain the importance of the Carnot cycle and write out the formula for the Carnot efficiency.***
- ***Describe with the aid of a T – s diagram, the thermodynamic processes of a Carnot cycle.***
- ***Using the data for the minimum and maximum temperatures in the Otto cycle, calculate for the same compression ratios, the Carnot efficiency and plot this on the same graph as the Otto efficiency.***
- ***Compare the two efficiencies and explain why the Otto cycle is not as efficient as the Carnot cycle.***

PART 2 REAL ENGINES

LIMITING VALUES

Study books on engine performance and write a section explaining what limits the compression ratio in real engines. You should find out about the following.

• ***What are typical compression ratios?***
• ***What are the maximum temperatures and pressures that a modern engine can withstand?***
• ***Why are real engines less efficient than predicted by the Otto formula?***
• ***What are the main energy losses?***

Write a concise report on the following methods of improving engine performance. Explain the improvement they make to engine performance and why they produce improvements.

• ***Supercharging.***
• ***Turbocharging.***
• ***Intercooling.***

PART 3 WASTE HEAT RECOVERY

Write a concise report explaining how the heat losses from large industrial engines may be recovered and used. You should write about the following.

• ***Waste heat boiler***
• ***Combined power and heating***
• ***The use of heat pumps.***

PART 4 ENGINE TESTING

The results below were obtained from a test on a ***four stroke*** engine. Using the data set allocated to you, determine the following.

The fuel used per second.
The Fuel Power.
The Brake Power.
The Mean Effective Pressure.
The Indicated Power.
The Mechanical Efficiency.
The Indicated Thermal Efficiency.
The Brake Thermal Efficiency.

	1	2	3	4	5	6	7	8	9
Air Fuel Ratio	14	12	12	16	17	12	13	14	15
Air flow rate g/s	100	60	130	250	350	5	25	450	400
Calorific value MJ/kg	46	46	45	48	46	46	46	48	48
No of cylinders	4	4	6	6	6	2	4	4	6
Crank speed rev/min	3500	2500	3000	6000	4000	1500	2500	6000	2000
Torque Arm m	0.5	0.4	0.6	0.6	0.6	0.3	0.4	0.65	0.75
Net brake force N	520	450	730	560	860	115	315	1200	2500
Cylinder bore mm	50	45	65	70	60	40	50	70	80
Piston stroke mm	50	60	50	60	60	60	60	60	66
Indicator diagram area mm^2	280	250	320	250	350	250	250	375	455
Base length of diagram mm	65	75	70	70	65	65	65	80	70
Pressure Scale MPa/mm	2.3	2.0	1.6	1.2	1.5	1.1	1.1	2.75	2.3