UNIT 61: ENGINEERING THERMODYNAMICS

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

ASSIGNMENT 4.1 POWER PLANT

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
L04 Understand the operation of steam and gas turbine power plant	4.1 explain the principles of operation of steam and gas turbines	
	4.2 illustrate the functioning of steam power plant by means of circuit and property diagrams	
	4.3 determine the performance characteristics of steam power plant.	

Grade	Descriptor	Achieved
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

PART 1 THE USE OF TURBINES

1. ***Explain with the aid of diagrams the basic principles of a reaction turbine and an impulse turbine.***
2. ***Explain in general terms the main applications of both.***
3. ***Find and describe at least one real application of each (ideally one from your work place).***
4. ***Explain the meaning of "combined heating and power plant". Explain how this might be done with the following.***
    - A pass out turbine
    - A back pressure turbine.
    - A gas turbine.

PART 2 STEAM POWER PLANT

1. ***Using correct plant symbols, draw a circuit of a steam power plant that has the following features. You may use a CAD system or traditional methods to draw the circuit.***

BOILER

The boiler unit contains the following.

- Economiser
- Evaporator
- Superheater
- Reheater

TURBINE

- A high pressure cylinder
- An intermediate pressure cylinder
- A double low pressure cylinder

Reheating takes place between the hp and ip cylinders.

CONDENSER

The condenser has an air extraction pump connected to it.

COOLING CIRCUIT

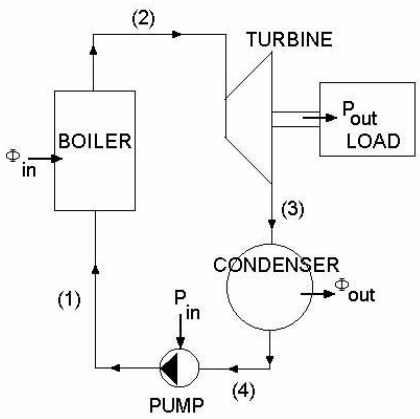
The cooling circuit uses two pumps and a cooling tower.

FEED WATER CIRCUIT

The feed water circuit comprises of the following.

- Extraction pump.
- Hot well
- Low pressure feed pump
- High pressure feed pump
- One direct contact feed water heater between the feed pumps using steam bled from between the i.p. and l.p. cylinders.

PART 3 RANKINE CYCLE



A simple steam power plant works as follows. Water is pumped into the boiler at point (1) on the diagram. Superheated steam leaves the boiler and goes to the turbine at point (2). The steam leaving the turbine is wet with dryness fraction x and goes to a steam condenser at (3). The condenser turns the steam into saturated water and this goes to a pump at (4) and the cycle is repeated.
The turbine has an isentropic efficiency of η_i %. You should assume that the pump uses perfect compression. Given the set of conditions for each point in the circuit you must do the following.

1. Sketch the cycle on the enthalpy – entropy chart (h – s) attached.
2. Sketch the cycle on a temperature – entropy chart (T – s) attached.
3. Calculate the ideal and actual dryness fraction at point (3)
4. Calculate the ideal and actual enthalpy at point (3)
5. Determine the enthalpy at each point in the cycle.
6. Calculate the heat transfer rate into the boiler (Φ_{in}).
7. Calculate the work transfer rate from the turbine (P_{out}).
8. Calculate the heat transfer rate from the condenser (Φ_{out}).
9. Calculate the thermal efficiency of the plant. (η_{th})
10. Calculate and compare the Carnot Efficiency (η_c) using the maximum and minimum cycle temperatures.

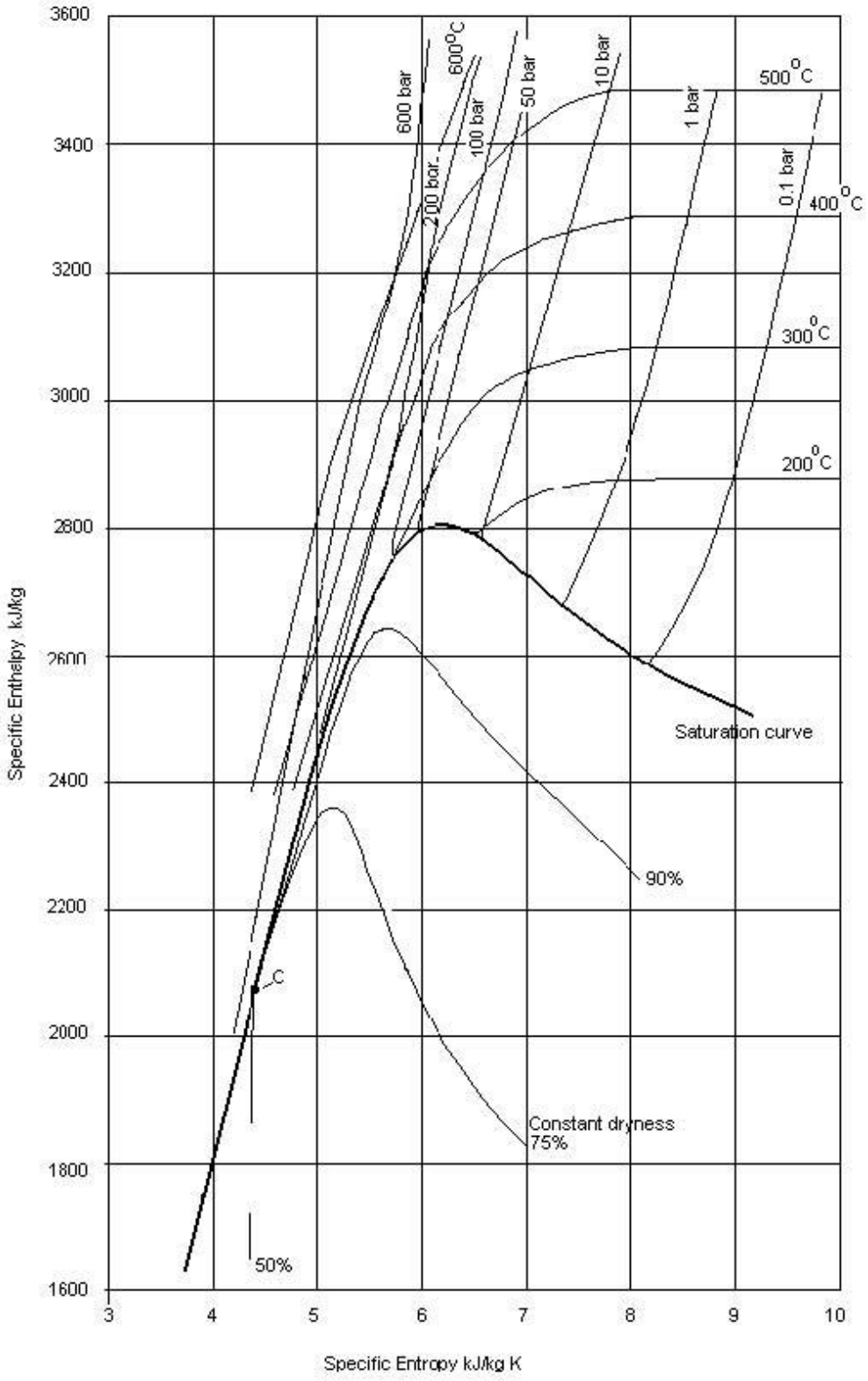
	Student	p_1 bar	p_3 bar	θ_2 °C	η_i %
1		40	400	0.035	92
2		100	0.07	400	85
3		60	0.5	450	87
4		50	0.05	300	90
5		100	0.04	600	84
6		15	0.1	300	88
7		20	0.1	350	86
8		70	0.08	500	91
9		90	0.09	450	93

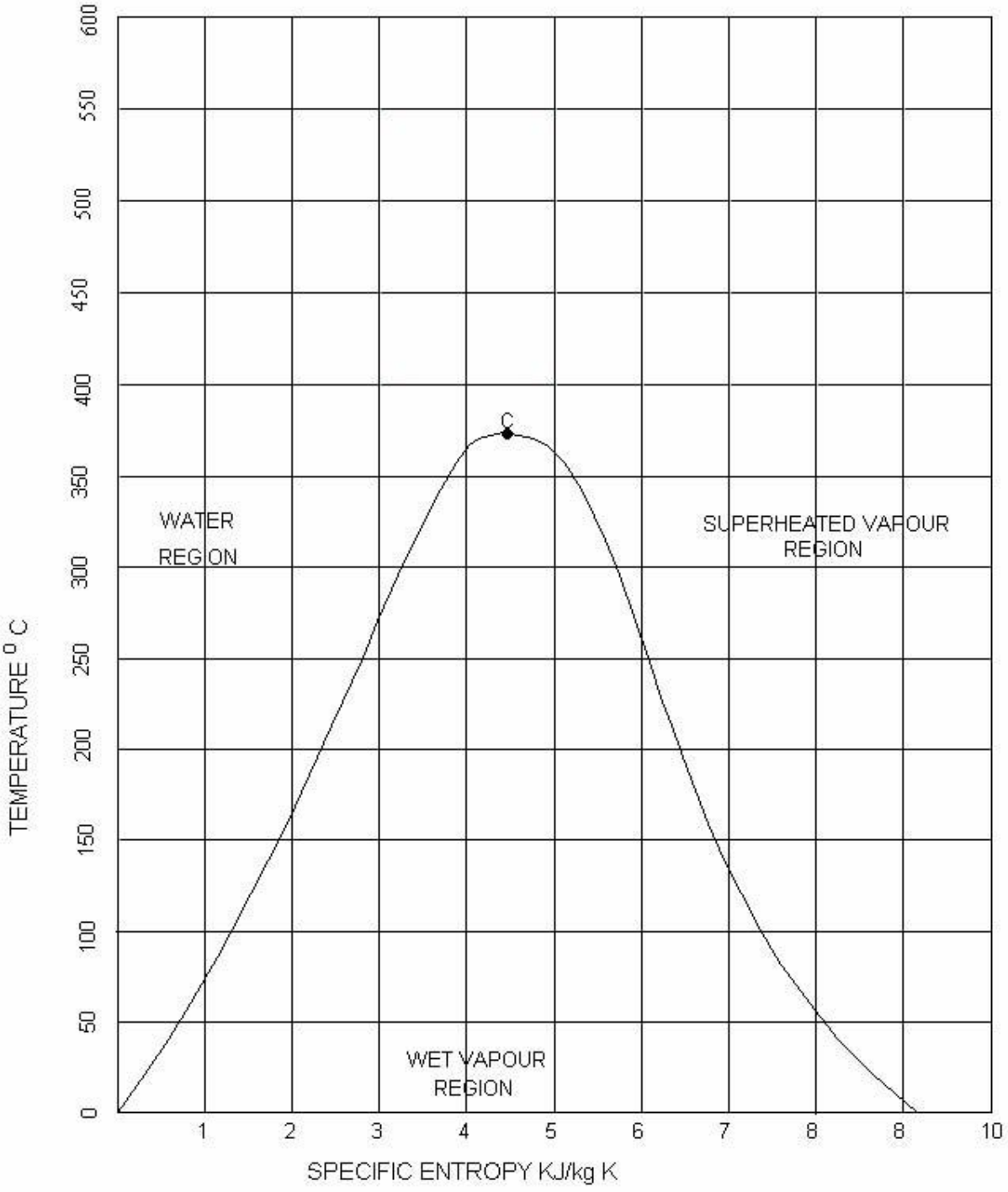
PART 4 GAS TURBINE POWER PLANT

1. ***Find out where and for what gas turbines are used. Using diagrams, pictures and any other method, describe the main examples, possibly drawing on examples from your work place.***

2. ***Using the correct plant symbols, draw a circuit sketch of a gas turbine power plant showing the following features. Explain the purpose of each item. You may use a CAD system or traditional methods to draw the circuit.***
   - Two stages of compression with an intercooler.
   - Two stages of expansion with reheating between stages.
   - An exhaust gas heat exchanger.

The turbines are arranged in series and the hp turbine drives the compressor only.


3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
3
4
5
6
7
8
9
10
Specific Enthalpy kJ/kg
Specific Entropy kJ/kg K
600 bar
600°C
100 bar
50 bar
10 bar
1 bar
0.1 bar
200 bar
500°C
400°C
300°C
200°C
Saturation curve
90%
C
Constant dryness
75%
50%


TEMPERATURE °C
0
50
100
150
200
250
300
350
400
450
500
550
600
C
WATER
REGION
SUPERHEATED VAPOUR
REGION
WET VAPOUR
REGION
1
2
3
4
5
6
7
8
8
10
SPECIFIC ENTROPY KJ/kg K