



INTERNAL ASSESSMENT APPROVAL FORM (INCLUDING COLLABORATIVE PROVISION)

This form is used to ensure that assessment specifications have been through an internal review process prior to external examination/approval and release to students. It should be completed for each assessment for a particular module. The assessment tasks, criteria and marking scheme should accompany this form.

PARTNER (and taught location if relevant):	Coleg Sirgar			
EXTERNAL EXAMINER NAME:	TO BE CONFIRMED			
ASSESSMENT AUTHOR:	CHRIS DAVIES			
MODULE TITLE:	SDM4004 (THERMOFLUIDS 1)			
MODULE CODE:	SDM4004	MODULE LEVEL:	4	
COMPONENT NO. (e.g. 1 of 2):	2 (Main + Resit Papers)	COMPONENT WEIGHTING (e.g. 50% of the module):	50%	
ASSESSMENT PERIOD	☐ Semester 1	☐ Semester 1 Re-sit	☐ Semester 2	☐ Semester 2 Re-sit
TYPE OF ASSESSMENT:	☐ Coursework ☒ Examination ☐ Practical ☐ Other, please state			
LANGUAGE OF ASSESSMENT:	English		TRANSLATION REQUIRED (Y/N):	N
FOR EXAMINATIONS ONLY. SPECIFY BELOW ANY ADDITIONAL MATERIAL(S) TO BE USED IN THE EXAMINATION				
This box will expand as you type				

INTERNAL MODERATOR PLEASE TICK TO INDICATE THAT THE ASSESSMENT INCLUDES:		Please ✓		Comments
		YES	NO	
1	Tasks that are specified clearly, accurately and comprehensibly, with appropriate use of language and neat presentation	✓		
2	Tasks which enable the module learning outcomes to be demonstrated (as per the module syllabus)	✓		
3	Tasks which conform to the assessment described in the module syllabus	✓		
4	Tasks which are written at the appropriate level of the Framework for Higher Education Qualifications (see http://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf?sfvrsn=170af781_14).	✓		
5	Clear criteria for assessment and guidance about how marking/grading will be applied	✓		
6	Guidance about expected evidence for submission, e.g. essay or report, word count, bibliography and references	n/a		For the Examination
7	Reference to good academic conduct, for example referencing, plagiarism and Turnitin	n/a		
8	Actions to complete	n/a		
This box will expand as you type				
SIGNATURE OF APPROVAL:		SIGNATURE		DATE
INTERNAL MODERATOR: I confirm that this version of the assessment specification is ready		Adam Twell		07/10/19

to be sent to the Partnership Team Leader		
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ONLY TO BE COMPLETED IF THE ASSESSMENT IS LINKED TO A COLLABORATIVE PARTNER

PARTNERSHIP TEAM LEADER PLEASE TICK TO INDICATE THAT THE ASSESSMENT INCLUDES:		Please ✓ YES NO		Comments
1	Tasks that are specified clearly, accurately and comprehensibly, with appropriate use of language and neat presentation			
2	Tasks which enable the module learning outcomes to be demonstrated (as per the module syllabus)			
3	Tasks which conform to the assessment described in the module syllabus			
4	Tasks which are written at the appropriate level of the Framework for Higher Education Qualifications (see http://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf?sfvrsn=170af781_14).			
5	Clear criteria for assessment and guidance about how marking/grading will be applied			
6	Guidance about expected evidence for submission, e.g. essay or report, word count, bibliography and references			
7	Reference to good academic conduct, for example referencing, plagiarism and Turnitin			
8	Actions to complete <i>This box will expand as you type</i>			
SIGNATURE OF APPROVAL:		SIGNATURE		DATE
PTL: I confirm that this version of the assessment specification is ready to be sent to the External Examiner				

UWTSD PROVISION: please submit the completed document to the appropriate Programme Director.

COLLABORATIVE PROVISION: please submit the completed document (or make available electronically) to the Partnership Team Leader. This must be in accord with specific arrangements for sharing electronic documents (e.g. via SharePoint or similar).

The assessment tasks, criteria and marking scheme should accompany this form

THIS DOCUMENT IS ALSO AVAILABLE IN WELSH

**UNIVERSITY OF WALES:
TRINITY SAINT DAVID**



**PRIFYSGOL CYMRU:
Y DRINDOD DEWI SANT**

LOCATION: COLEG SIR GAR (GRAIG)

LLEOLIAD: COLEG SIR GAR (GRAIG)

LEVEL 4

LEFEL 4

**EXAMINATION PERIOD
AUGUST 2020**

**CYFNOD ARHOLIADAU
AWST 2020**

**MODULE CODE: SGDM4004
THERMOFLUIDS 1**

TIME: 2 HOURS

ANSWER THREE QUESTIONS OUT OF FOUR

Equipment or materials required

Calculators are permitted

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Caniateir cyfrifiannellau

QUESTION 1

- a) State the First Law of Thermodynamics for a cycle. [4 marks]
- b) Explain why Heat and Work are considered to be different from other forms of energy and why they are not regarded as properties of a system. [5 marks]
- c) Define the following terms used in Thermodynamics
- i) Internal energy [1 marks]
 - ii) Specific heat capacity [1 marks]
 - iii) Latent heat [1 marks]
- d) Air enters a gas turbine at a pressure and temperature of 10 bar and 800°C respectively. The air expands through the turbine to an outlet pressure of 1.2 bar in an adiabatic expansion according to the law $PV^\gamma = C$.

Calculate the power developed by the turbine if the mass flow of air is 2.5 kg/s.

[13 marks]

Assuming air is an ideal gas, calculate the velocity at exit from the nozzle.
Take specific heat capacity at constant pressure $C_p = 1.005 \text{ kJ/kgK}$
and the specific heat capacity at constant volume $C_v = 0.715 \text{ kJ/kgK}$

Total Marks for Question Q1 = 25

QUESTION 2

Air is compressed in an air compressor from a pressure of 1.1 bar and a volume of 0.2 m^3 , according to the law $PV^{1.2} = C$, to a pressure of 8 bar. This is followed by a constant pressure cooling process to a volume of 0.008 m^3 and then an expansion back to the initial pressure in a process of the form $PV^n = C$. The volume at this point is 0.017 m^3 . A constant pressure process completes the thermodynamic cycle.

- a) Explain what is meant by a 'Thermodynamic Cycle'. [5 marks]
- b) Sketch the cycle on a pressure-volume diagram. [5 marks]
- c) Calculate the net work done of the cycle. [15 marks]

Total Marks for Question Q2 = 25

QUESTION 3

- a) Explain what is meant by the term 'pressure head'.
[3 marks]
- b) State what the relationship is between the pressure head, and the pressure in a fluid system.
[3 Marks]
- c) State the three forms of energy that a fluid in motion may possess and give expressions for each.
[3 marks]
- d) Define 'volumetric flow rate'.
[3 marks]
- e) Find the velocity of water issuing from a hole near the base of a 3 m high cylindrical tank when it is
i) Full. [3 marks]
ii) Half-full. [2 marks]
- f) A pipe contains a gradually tapering section in which its diameter increases from 450 mm to 300 mm as shown in Figure Q3. The pipe contains an incompressible fluid of density 1000 kg/m^3 and runs full. If the flow velocity is 3.5 m/s in the smaller diameter, determine the velocity in the larger diameter, the volumetric flow rate and the mass flow rate.

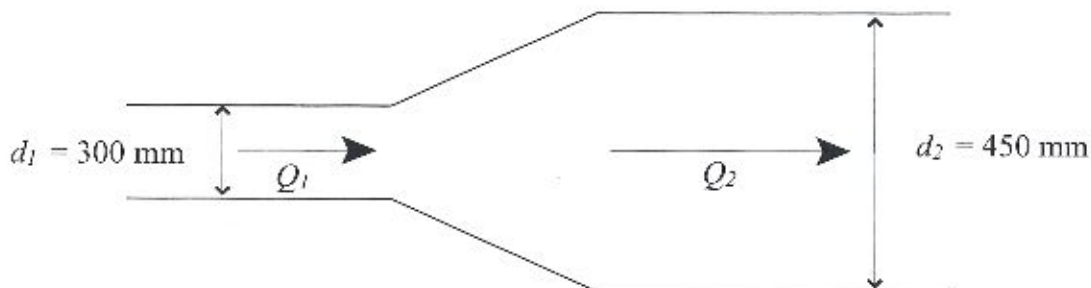


Figure Q3

[8 marks]

Total Marks for Question Q3 = 25

QUESTION 4

- a) Explain what is meant by the specific heats of a gas. Give the definitions of the two specific heats and the relationships between them. **[5 marks]**
- b) A perfect gas occupies a volume of 0.12m^3 at a temperature of 27°C and a pressure of 2.3bar . It is compressed according to an adiabatic law to a final pressure of 6 bar . Calculate:
- i) the mass of gas present
 - ii) the final temperature
 - iii) the final volume
 - iv) the work required to compress the gas
 - v) the gain in internal energy

[20 marks]

Take the specific heat at constant pressure = 1.075kJ/kgK and the specific heat at constant volume = 0.78kJ/kgK

Total marks for Question 4 = 25 marks

DATA SHEET

Motion

$$v = u + at$$

$$s = ut + \frac{1}{2} at^2$$

$$v^2 = u^2 + 2as$$

$$s = \left(\frac{u+v}{2} \right) t$$

$$\omega_2 = \omega_1 + \alpha t$$

$$\theta = \omega_1 t + \frac{1}{2} \alpha t^2$$

$$\omega_2^2 = \omega_1^2 + 2\alpha\theta$$

$$\theta = \left(\frac{\omega_1 + \omega_2}{2} \right) t$$

$$v = \omega r, \quad a = \alpha r$$

$$s = \theta r$$

Elasticity

$$\sigma = \frac{P}{A}, \quad \epsilon = \frac{\delta L}{L}$$

$$E = \frac{\sigma}{\epsilon}$$

$$\nu = \frac{\epsilon_{\text{lat}}}{\epsilon_{\text{long}}}$$

$$\tau = \frac{V}{A_R}, \quad G = \frac{\tau}{\gamma}$$

$$FOS = \frac{P_{\text{failure}}}{P_{\text{allowable}}} = \frac{\sigma_{\text{failure}}}{\sigma_{\text{allowable}}}$$

Bending and Torsion

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

$$Z = \frac{I}{y_{\text{max}}}$$

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$

Gear Ratio

$$\frac{\text{Speed of A}}{\text{Speed of B}} = \frac{\text{Teeth on B}}{\text{Teeth on A}}$$

Forces

$$F = \mu N$$

$$F = -kx$$

$$F = ma$$

SHM

$$T = \frac{2\pi}{\omega}, \quad f = \frac{1}{T}$$

$$\omega = 2\pi f$$

$$T = 2\pi \sqrt{\frac{l}{g}}$$

$$\frac{k}{m} = \frac{g}{\delta}$$

$$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{g}{l}} = \sqrt{\frac{g}{\delta}}$$

$$v = -\omega \sqrt{r^2 - x^2}$$

$$v = -\omega r \sin \theta$$

$$a = -\omega^2 r \cos \theta$$

$$a = -\omega^2 x$$

Work, Energy and Power

$$WD = F \times s$$

$$P = \frac{WD}{t} = F \times v$$

$$PE = mgh$$

$$KE = \frac{1}{2} mv^2$$

Impulse and Momentum

$$F = \frac{m(v-u)}{t}$$

$$H_u = mu, \quad H_v = mv$$

$$J = F \times t$$

$$H_v = H_u + J$$

$$m_A u_A + m_B u_B = m_A v_A + m_B v_B$$

$$e = \frac{v_B - v_A}{u_A - u_B}$$

Thermodynamic Process

$$\text{Polytropic Process - } PV^n = C$$

$$\text{Work Transfer - } W = \frac{P_1 V_1 - P_2 V_2}{n-1}$$

$$\text{Isothermal Process - } W = P_1 V_1 \ln \frac{v_2}{v_1}$$

Perfect Gases

$$\text{Characteristic Gas Equation}$$

$$PV = mRT$$

$$\text{Other useful relationships -}$$

$$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2} \right)^{\frac{n-1}{n}}, \quad \frac{T_1}{T_2} = \left(\frac{v_2}{v_1} \right)^{n-1}$$

$$C_v = \left(\frac{du}{dT} \right)_p, \quad c_p = \left(\frac{dh}{dT} \right)_p$$

Steam and Properties of Vapours

$$\text{Enthalpy of wet steam} = hf + xhfg$$

$$\text{Specific volume of wet steam} = xv_g$$

$$\text{Mass of vapour } m = \frac{V}{v}$$

EXAMINATION SOLUTIONS

(to accompany the examination paper sent to the external examiner
but NOT to be seen by students)

Programme:	HNC MECHANICAL ENGINEERING	Level:	4
Module:	SGDM4004 THERMOFLUIDS 1		
Author:	CHRIS DANIEL	Page:	1 / 4

Q1	Question	Marks
(a)	When a system undergoes a thermodynamic cycle the net heat transfer is equal to the net work transfer	(4)
(b)	Heat and work are transient forms of energy and so are not stored within the system but occur at the system boundary and can be considered interchangeable	(5)
(c)	Internal energy due to molecular motion Specific heat capacity - heat required to heat 1 kg of a substance of 1K by 1 Kelvin Latent heat - Associate with heat required to change the state of a substance	(6)
(d)	 $p_1 v_1^n = c$ $p_1 = 1 \text{ bar}$ $T_1 = 1078 \text{ K}$ $\gamma = c_p / c_v$ $\dot{m} = 2.5 \text{ kg/s}$ $p_2 = 1.2 \text{ bar}$ $\gamma = 1.005 / 0.713 = 1.41$ $q - w = h_2 - h_1 + \frac{v_2^2 - v_1^2}{2000} + 5(z_2 - z_1)$ <u>Assumptions stated</u> $T_1 / T_2 = (p_1 / p_2)^{\frac{\gamma-1}{\gamma}}$ $\frac{T_1}{T_2} = (1.2)^{\frac{0.41}{1.41}}$ $\frac{T_1}{T_2} = (1.33)^{0.291} \approx 1.1$ $T_2 = 1078 / 1.1 = 980 \text{ K}$ $T_2 = 579 \text{ K}$ $w = 1.005(1078 - 579) = 494 \text{ kJ/kg}$ $\dot{w} = 2.5 \times 494 = 1235 \text{ kW}$	(2)
		(3)
		(3)
		(3)(2)

Q2	Question	Marks
(a)	A THERMODYNAMIC CYCLE CAN BE DEFINED AS WHERE THE STARTING & ENDING CONDITIONS ARE THE SAME	(5)
(b)	$P_1 = 1.1 \text{ bar}$ $V_1 = 0.2 \text{ m}^3$ $P_2 = 8 \text{ bar}$ $V_2 = ?$ $P_3 = 8 \text{ bar}$ $V_3 = 0.008 \text{ m}^3$ $P_4 = 1.1 \text{ bar}$ $V_4 = 0.017 \text{ m}^3$	(5)
(c)	$W_{1-2} = \frac{P_1 V_1 - P_2 V_2}{n-1} \quad \& \quad P_1 V_1^n = P_2 V_2^n$ $\therefore (V_2)^{1.2} = \frac{1.1 \times 10^5 \times (0.2)^{1.2}}{8 \times 10^5}$ $V_2 = 1.2 \sqrt{0.0199} \quad \quad V_2 = 0.038 \text{ m}^3$ $\therefore W_{1-2} = \frac{(1.1 \times 10^5 \times 0.2) - (8 \times 10^5 \times 0.038)}{1.2 - 1} \quad \quad W_{1-2} = -42000 \text{ J} \quad (3)$ $W_{2-3} = P(V_3 - V_2) = 8 \times 10^5 (0.008 - 0.038)$ $W_{2-3} = -24000 \text{ J} \quad (3)$ $W_{3-4} = \frac{P_3 V_3 - P_4 V_4}{n-1} \quad \& \quad P_3 V_3^n = P_4 V_4^n$ $8 \times 10^5 \times (0.008)^n = 1.1 \times 10^5 \times (0.017)^n$ $\frac{8 \times 10^5}{1.1 \times 10^5} = \left(\frac{0.017}{0.008} \right)^n \quad \quad \ln 7.27 = n / \ln 2.125$ $n = \frac{\ln 7.27}{\ln 2.125} \quad \quad n = 2.63$ $\therefore W_{3-4} = \frac{(8 \times 10^5 \times 0.008) - (1.1 \times 10^5 \times 0.017)}{2.63 - 1} \quad \quad W_{3-4} = 2779 \text{ J} \quad (3)$ $W_{4-1} = P(V_1 - V_4)$ $= 1.1 \times 10^5 (0.2 - 0.017) = W_{4-1} = 20130 \text{ J} \quad (3)$ $\text{NET } W.D = -43091 \text{ J} \quad (3)$	

Q3	Question	Marks
(a)	HEIGHT OF A COLUMN OF FLUID THAT WILL PRODUCE A GIVEN PRESSURE.	(2)
b)	$P = \rho g h$	(3)
c)	PRESSURE ENERGY (FLOW ENERGY) = $\frac{PM}{A}$	(1)
	$P.E = mgh$	(1)
	$K.E = \frac{1}{2} MC^2$	(1)
d)	THE VOLUME OF FLUID THAT PASSES THROUGH A GIVEN SURFACE PER UNIT TIME (m^3/s or L/s)	(3)
e)	$h = 3m$, $C_1 = 0$ (AT SURFACE) $P_1 = P_2$ (ATMOSPHERIC PRESSURE) $h_2 = 0$ (AT BASE) $\therefore h_1 + 0 + \frac{P_1}{\rho g} = 0 + \frac{C_2^2}{2g} + \frac{P_2}{\rho g}$ <u>AT 3m</u> $C_2 = \sqrt{2gh}$ $C_2 = \sqrt{2 \times 9.81 \times 3}$ $C_2 = 7.67 m/s$ <u>AT 1.5m</u> $C_2 = \sqrt{2 \times 9.81 \times 1.5}$ $C_2 = 5.42 m/s$	(2) (2)
f)	$Q = C_1 A_1 = C_2 A_2$ $\pi r_1^2 C_1 = \pi r_2^2 C_2$ $r_1^2 C_1 = r_2^2 C_2$ $\therefore C_2 = \frac{150^2 \times 3.5}{225^2} = 1.55 m/s$ $\dot{Q} = A_1 C_1 = \pi r_1^2 \times C_1 = \pi (150 \times 10^{-3})^2 \times 32 = 0.247 m^3/s$ $\dot{m} = \rho A_1 C_1 = 0.247 \times 1000 = 247 kg/s$	(3) (3) (2)

Q4	Question	Marks
(a)	Specific heats C_p & C_v defined $C_p - C_v = R$ $\gamma = C_p / C_v$	(5)
(b)	$P_1 = 2.3 \text{ bar}$ $V_1 = 0.12 \text{ m}^3$ $T_1 = 300 \text{ K}$ $P_2 = 6 \text{ bar}$ $pV^\gamma = c$ $\gamma = C_p / C_v = \frac{1.005}{0.78} = 1.378$ $R = 1.075 - 0.78$ $R = 0.295 \text{ kJ/kgK}$	
(i)	$P_1 V_1 = nRT_1$ $\therefore n = \frac{P_1 V_1}{RT_1} = \frac{2.3 \times 10^5 \times 0.12}{295 \times 300}$ $n = 0.312 \text{ kg}$	(4)
(ii)	$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}$ $\frac{300}{T_2} = \left(\frac{2.3}{6}\right)^{\frac{0.378}{1.378}}$ $T_2 = \frac{300}{0.7685}$ $T_2 = 390.4 \text{ K}$	(4)
(iii)	$P_1 V_1^\gamma = P_2 V_2^\gamma$ $2.3 \times (0.12)^{1.378} = 6 \times V_2^{1.378}$ $V_2^{1.378} = 0.02064$ $\therefore V_2 = 0.0598 \text{ m}^3$	(4)
(iv)	$W \cdot \theta = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1} = \frac{(2.3 \times 10^5 \times 0.12) - (6 \times 10^5 \times 0.0598)}{1.378 - 1}$ $W = -21905 \text{ J}$	(4)
(v)	$Q - W = U_2 - U_1$ $\therefore U_2 - U_1 = -W = 21905 \text{ J}$	(4)
		<u>25</u>