



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:	SDMH4004 (THERMOFLUIDS 1)				
MODULE CODE:	SDMH4004	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	Other, please state
TYPE OF ASSESSMENT:	☐ Coursework		☒ Examination		☐ Practical
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?stfrsn=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 more 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 ✓		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			
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)
AND PEMBROKESHIRE COLLEGE**

**LLEOLIAD: COLEG SIR GAR (GRAIG)
AND COLEG SIR BENFRO**

LEVEL 4

LEFEL 4

**EXAMINATION PERIOD
MAY 2020**

**CYFNOD ARHOLIADAU
MAI 2020**

**MODULE CODE: SGDM4004
THERMOFLUIDS 1**

TIME: 2 HOURS

ANSWER ANY THREE QUESTIONS OUT OF FOUR

Equipment or materials required

Calculators are permitted

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Caniateir cyfrifiannellau

QUESTION 1

- a) What is meant by the term pressure head? [3 Marks]
- b) Using an appropriate diagram explain what is the difference between gauge pressure and absolute pressure. [3 marks]
- c) Write down an expression for the variation of gauge pressure with depth in a liquid. Give a definition of each term in the expression including their units. [4 marks]
- d) The gauge pressure in a liquid at a depth of 2 m is read to be 28 kPa. Determine the gauge pressure in the same liquid at a depth of 12 m. [5 marks]
- e) Water flows through a horizontal pipe at a rate of $0.025 \text{ m}^3/\text{s}$. The pressure at the inlet of the pipe is 400 kN/m^2 and the pipe diameter is 0.15m. At the outlet of the pipe the diameter is 0.1m. If the mass density of the water is 1000 kg/m^3 , calculate the pressure at the outlet.

[10 marks]

Total Marks for Question 1 = 25

QUESTION 2

A theoretical cycle consists of the following processes:

- (i) a polytropic compression process from a pressure of 1 bar and a volume of 0.65 m^3 according to the law $PV^{1.1} = C$, to a pressure of 5 bar
- (ii) a constant volume heating process to a pressure of 8 bar
- (iii) a constant pressure heating process
- (iv) a polytropic expansion to a pressure of 2.5 bar according to the law $PV^{2.2} = C$
- (v) a constant volume cooling process back to the initial conditions.

- a) Sketch the cycle on a pressure-volume diagram and calculate the net work for the cycle. [20 marks]
- b) Is the work done by the system or a work done on the system? Give reasons for your answer.

[5 marks]

Total Marks for Question Q2 = 25

QUESTION 3

- a) Explain the first law of thermodynamics in the context of conservation of energy principle.

[5 marks]

- b) In thermodynamics, define the following terms:

- (i) An adiabatic process
- (ii) Enthalpy
- (iii) An isothermal process
- (iv) Absolute temperature

[4 marks]

- c) Air enters a horizontal nozzle with a pressure of 7 bar and with a temperature of 200°C . The air expands through the nozzle to an exit pressure of 1 bar according to the law $PV^{1.25} = \text{constant}$.

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 $C_v = 0.715 \text{ kJ/kgK}$.

[16 marks]

Total Marks for Question 3 = 25

QUESTION 4

- a) What is the thermodynamic definition of a "perfect gas" and what is meant by the specific heats of a perfect gas?

[5 Marks]

- b) In thermodynamics, explain what is meant by closed and open system and give an example of each.

[5 Marks]

- c) A perfect gas at a temperature of 150°C and a pressure of 10 bar occupies a volume of 0.25m^3 . It is expanded until the volume becomes 0.85m^3 according to the law $PV^{\gamma} = C$.

Calculate:

- (i) The final pressure
- (ii) The final temperature
- (iii) The work done during the expansion
- (iv) The mass of gas present

[15 marks]

Take specific heat capacity at constant pressure $C_p = 1.075 \text{ kJ/kgK}$
and the specific heat capacity at constant volume $C_v = 0.78 \text{ kJ/kgK}$

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

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

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

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

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

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

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

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

$$\omega = 2\pi f$$

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

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

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

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

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

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

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

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

$$\text{Characteristic Gas Equation}$$

$$PV = mRT$$

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

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

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

Steam and Properties of Vapours

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

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

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

EXAMINATION SOLUTIONS

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

Programme:	MNC Mechanical Engineering	Level:	4
Module:	Thermofluids 1 SGDM4003 ~~Thermofluids 1~~ (MAIN)		
Author:	Chris Davies	Page:	11

Q1	Question	Marks
1(a)	Pressure head is the height a column of fluid (or depth in a fluid) which corresponds to the pressure in the fluid	(3)
(b)	 $\text{Gauge pressure} = \rho g h$  $P_{\text{atm}} = 1.01 \text{ bar}$	(3)
(c)	$\rho = \text{density of fluid (kg/m}^3\text{)}$ $h = \text{height (m)}$ $\text{Absolute pressure} = \text{Gauge pressure} + \text{Atmospheric pressure}$	(4)
(d)	$P = \rho g h$ solving pressure = $12/2 \times 28 = 168 \text{ kPa}$	(5)
(e)	$\frac{P_1}{\rho g} + \frac{C_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{C_2^2}{2g} + z_2 + \frac{h_f}{L}$ Using $Q = CA$ $C_1 = Q/A = \frac{0.025}{\pi \times 0.075^2} = 1.42 \text{ m/s}$ $C_2 = \frac{0.025}{\pi \times 0.05^2} = 3.18 \text{ m/s}$ $\frac{400000}{9810} + \frac{1.42^2}{19.62} = \frac{P_2}{9810} + \frac{(3.18)^2}{19.62}$ $(40.87 - 0.115)$ $\Rightarrow P_2 = 395,878 \text{ Pa (10)}$ $P_2 = 3.95 \text{ bar}$	

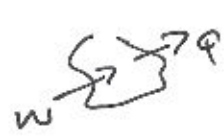
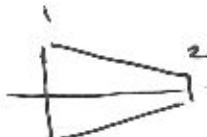


Q2	Question	Marks
	$P_1 = 1 \text{ bar}$ $V_1 = 0.65 \text{ m}^3$ $P_2 = 5 \text{ bar}$ $V_2 = ?$ $PV^{1.1} = C$ $P_3 = 8 \text{ bar}$ $V_3 = V_2 = ?$ $P_4 = 8 \text{ bar}$ $V_4 = ?$ $P_5 = 2.5 \text{ bar}$ $V_5 = V_1 = 0.65 \text{ m}^3$ $PV^{2.2} = C$ (5)	
	$W_{D1-2} = \frac{P_1 V_1 - P_2 V_2}{n-1} \quad P_1 V_1^n = P_2 V_2^n$ $\frac{1 \times 10^5 \times (0.65)^{1.1}}{5 \times 10^5} = V_2^{1.1}$ $V_2 = 0.15 \text{ m}^3$ $\therefore W_{D1-2} = \frac{(1 \times 10^5 \times 0.65) - (5 \times 10^5 \times 0.15)}{1.1 - 1} \quad W_{D1-2} = -100000 \text{ J}$ (3)	
	$W_{D2-3} = 0 \text{ J}$ (3)	
	$W_{D5-1} = 0 \text{ J}$ (3)	
	$W_{D4-5} = \frac{P_4 V_4 - P_5 V_5}{n-1} \quad P_4 V_4^n = P_5 V_5^n$ $8 \times 10^5 \times (V_4)^{2.2} = (2.5 \times 10^5) \times (0.65)^{2.2}$ $V_4^{2.2} = 0.121$ $V_4 = \sqrt[2.2]{0.121}$ $V_4 = 0.38 \text{ m}^3$ $\therefore W_{D4-5} = \frac{(8 \times 10^5 \times 0.38) - (2.5 \times 10^5 \times 0.65)}{2.2 - 1}$ $W_{D4-5} = 117917 \text{ J}$ (3)	
	$W_{D3-4} = P(V_4 - V_3) = 8 \times 10^5 (0.38 - 0.15)$ $W_{D3-4} = 184000 \text{ J}$ (3) (5)	
	$\text{Total} = 201,917 \text{ J} \quad \text{+ve (done by system)}$ (5)	



Q 4	Question	Marks
(a)	SPECIFIC HEATS - HEAT REQUIRED TO RAISE 1KG OF A SUBSTANCE BY 1K (AT CONSTANT PRESSURE OR VOLUME) $R = C_p - C_v$ $\gamma = C_p / C_v$	(5)
(b)	CLOSED SYSTEM - NO MASS FLOW OVER THE SYSTEM BOUNDARY (e.g. PISTON / CYLINDER) OPEN SYSTEM - MASS FLOW OVER SYSTEM BOUNDARY (e.g. TURBINE)	(5)
(c)	$P_1 = 10 \text{ bar}$ $T_1 = 423 \text{ K}$ $V_1 = 0.25 \text{ m}^3$ $PV^\gamma = C$ $V_2 = 0.85 \text{ m}^3$ $\gamma = C_p / C_v$ $\gamma = \frac{1.005}{0.713} = 1.41$	(2)
(i)	$P_1 V_1^\gamma = P_2 V_2^\gamma$ $10 \times 10^5 \times (0.25)^{1.41} = P_2 \times (0.85)^{1.41}$ $\frac{141610.5}{0.795} = P_2$ $P_2 = 1.78 \text{ bar}$	(3)
(ii)	$\frac{T_1}{T_2} = \left(\frac{P_1}{P_2}\right)^{\frac{\gamma-1}{\gamma}}$ $\frac{423}{T_2} = \left(\frac{10 \times 10^5}{1.78 \times 10^5}\right)^{\frac{1.41-1}{1.41}}$ $T_2 = 256.1 \text{ K}$	(3)
(iii)	$W.D = \frac{P_1 V_1 - P_2 V_2}{\gamma - 1} = \frac{(10 \times 10^5 \times 0.25) - (1.78 \times 10^5 \times 0.85)}{1.41 - 1}$ $W.D = 240,731.7 \text{ J}$	(3)
(iv)	$W = MRT$ $M = \frac{PV}{RT} = \frac{10 \times 10^5 \times 0.25}{295 \times 423} = 2 \text{ Kg}$	(4)



Q 3	Question	Marks
(a)	HEAT AND WORK ARE BOTH TRANSFER FORMS OF ENERGY PASS IN AND OUT OF THE SYSTEM. FROM APPLYING LAWS OF CONSERVATION OF ENERGY $\boxed{\sum W = \sum Q}$ 	(5)
(b)(i)	ADIABATIC PROCESS - (CONSTANT HEAT)	(1)
(ii)	ENTHALPY - TOTAL ENERGY INTERNALLY OR $U + PV$	(1)
(iii)	ISOTHERMAL - CONSTANT TEMPERATURE	(1)
(iv)	ABSOLUTE TEMP - MEASURED IN KELVIN ON THE ABSOLUTE SCALE	(1)
(c)	 $P_2 = 1 \text{ bar}$ $PV^\gamma = C$ $P_1 = 7 \text{ bar}$ $T_1 = 200^\circ\text{C}$ $h_1 - h_2 = (h_2 - h_1) + \left(\frac{C_2^2 - C_1^2}{2000} \right) + \frac{g(z_2 - z_1)}{1000}$ $\therefore 0 = h_2 - h_1 + \frac{C_2^2}{2000}$ $C_2 = \sqrt{2000(h_1 - h_2)} = \sqrt{2000 \cdot C_p(T_1 - T_2)}$ $\frac{T_1}{T_2} = \left(\frac{P_1}{P_2} \right)^{\frac{\gamma-1}{\gamma}} \quad \gamma = \frac{C_p}{C_v} = \frac{1.005}{0.715} = 1.41$ $\frac{473}{T_2} = \left(\frac{7 \times 10^5}{1 \times 10^5} \right)^{\frac{1.41-1}{1.41}} \quad \therefore T_2 = 268.6 \text{ K}$ $\therefore C_2 = \sqrt{2000 \times 1.005(473 - 268.6)}$ $C_2 = \underline{646.9 \text{ m/s}}$	(4) (2) (4) (6)