ENERGY ENGINEERING (MEEN 10050)

Numerical **Answers** to **Section B** Examination Questions (2011, 2012, 2-13)

Summer 2013 (2012-13 Academic Session, End of Semester Paper)

Question B1:

(a) What are the U-values of the two walls? $\boxed{U_A = 2.855\ W/m^2.K}$ $\boxed{U_B = 1.4235\ W/m^2.K}$

(b) What is the temperature T_2 of the air in the unheated room? $T_2 = 14.0\ ^oC$

(c) What is the temperature T_1 of the air in the heated room? $T_2 = 21.0\ ^oC$

Question B2:

For H_2O at **State 1**: 200 kPa, 120.23°C, **State 2**: 10 MPa, 500°C

(a) the specific volume from the data tables,

$\boxed{v = 0.8857\ m^{-3} \bullet kg}$ $\boxed{v = 0.03279\, m^{-3} \bullet kg}$

(b) the specific volume calculated using the ideal gas equation and,

$\boxed{v = 0.9085\ m^{-3} \bullet kg}$ $\boxed{v = 0.03571\ m^{-3} \bullet kg}$

(c) the percentage error involved in assuming ideal gas behaviour.

$\boxed{\%\ error = -2.57\%}$ $\boxed{\%\ error = +8.91\%}$

Question B3

(i) The outlet temperature of the steam (°C), T_{exit} = **99.63 °C**

(ii) The change in specific enthalpy of the steam (kJ/kg), **878.9 kJ/kg**

(iii) The mass flow rate of steam required to yield a turbine mechanical power output of 50.0 MW (Neglecting potential energy changes and any mechanical friction losses in the turbine). $\boxed{\dot{m} = 5.69\ kg/s}$

Summer 2012 (2011-12 Academic Session, End of Semester Paper)

Question B1:

(a) What is the U-value of the wall? U = 0.349 W/m^{2}K

(b) What is the minimum capacity of a heater for that room? $\boxed{\dot{Q} = 157\ W}$

(c) What is the temperature of the external surface of the wall when the minimum temperature is observed? T_1 = -4.62°C

Question B2:

(1) the final volume, and $\boxed{V_2 = 0.02143\ \ m^3}$

(2) the final temperature (°C) $\boxed{T_2 = 497.86\ K = 224.7\ ^oC}$

Question B3

(A) What inlet water flow rate (in *litres* per minute) can be sustained if the outlet water temperature is to be 50°C at the exit from the heater? $\boxed{Q\ \ (litres/\min) = 2.3\ litres/\min}$

(B) What exit temperature (°C) would be achieved if this water flow rate were increased by 60%? $\boxed{Te = 33.12^oC}$

Summer 2011 (2010-11 Academic Session, End of Semester Paper)

Question B1:

(a) the steady state rate of heat transfer through this glass window $\boxed{\dot{Q} = 502.9\ W}$

(b) the overall heat transfer coefficient $\boxed{U = 5.466\, W.m^{-2}.K^{-1}}$

(c) the temperature of its inner surface for a time during the day $\boxed{T_2 = 2.3^o C}$

Question B2:

(a) The work done during this process $\boxed{{}_1W_2 = -9.46\ kJ}$

(b) The heat transferred. $\boxed{{}_1Q_2 = -9.46\ kJ}$

Question B3

(iv) The outlet temperature of the steam (°C), **60.06 °C**

(v) The change in specific enthalpy of the steam (kJ.kg^{-1}) **1104.6 kJ/kg**

(vi) The change in steam kinetic energy per unit mass (kJ.kg^{-1}) $\boxed{-1.2\ kJ/kg}$

(vii) The mass flow rate of steam required to yield a turbine mechanical power output of 50.0 MW (Neglecting any mechanical friction losses in the turbine) $\boxed{\dot{m} = 45.31\ kg/s}$

Christmas 2011 (2010-11 Academic Session, Resit Exam Paper)

Question B1

(a) the steady state rate of heat transfer through this glass window, $\boxed{\dot{Q} = 144.3\ W}$

(b) the overall heat transfer coefficient, and $\boxed{U = 4.357\, W.m^{-2}.K^{-1}}$

(c) the temperature of its outer surface for a time during the day $\boxed{T_2 = 2.6^o C}$

Question B2

(i) the pressure rise (in kPa) if the air temperature in the tyre rises to 80°C under racing conditions, neglecting any changes in the internal volume, $\boxed{\Delta P = P_2 - P_1 = 61.4(kPa)}$

(ii) the mass of air in the tyre, $\boxed{m_1 = 0.03564\ (kg)}$

(iii) the mass of air which must be bled off to restore the pressure to 300 kPa, at 80°C. $\boxed{\Delta m = m_1 - m_3 = 0.00606(kg)}$

Question B3

(i) The air temperature at exit from the duct (°C). $\boxed{T_{exit} = 31.3^o C}$

(ii) The air velocity at exit from the duct (m/s). $\boxed{\overline{V}_2 = 4.17\ m/s}$

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ENGINEERING THERMODYNAMICS & FLUID MECHANICS (MEEN 10010)

Numerical **Answers** to **Section B** of Examination Questions (2005-2010)

Summer 2010 (2009-10 Academic Session, End of Semester Paper)

Question B1: Overall Height of Left leg = 14.33 cm, Right leg = 15.86 cm

Question B2: (i) $\boxed{V_{total} = 0.006848\ m^3}$ (ii) $\boxed{m_{vap} = 0.003721\ kg}$

(iii) $\boxed{U_1 = 259.1\ kJ}$ (iv) T_{final} = 151.86 °C

Question B3 (1) $\boxed{V_2 = 0.0535\ \ m^3}$ (2) $\boxed{{}_1W_2 = -33.61\ kJ}$ (3) $\boxed{T_2 = 491.61\ K = 218.46\ {}^oC}$

Summer 2009 (2008-09 Academic Session, End of Semester Paper)

Question B1: (a): $\boxed{F = F_1 - F_2 = 2.04\times10^8\ N}$ (b) $\boxed{X = 27.9\ m}$

Question B2: (1) $\boxed{m_1 = 0.0011\ kg}$ (2) $\boxed{P_2 = 12.981\ MPa}$

(3) $\boxed{{}_1W_2 - 612.93\ J}$ (4) $\boxed{{}_1Q_2 = -76.48\ J}$

Question B3 (a) T_1 = 151.86°C (b) $\boxed{m_{total} = 915.58\ kg}$

(c) $\boxed{x_1 = 0.0007283}$ (d) $\boxed{U_2 = 699.4\ MJ}$

Summer 2008 (2007-08 Academic Session, End of Semester Paper)

Question B1: (1): $\boxed{P_A - P_B = 34688\ \ N/m^2}$

Question B2: (1) $\boxed{V_2 = 0.0179\ \ m^3}$ (2) $\boxed{T_2 = 142.65\ {}^oC}$

Question B3 (i) T_{exit} = <u>99.63 °C</u> (ii) <u>880.6 kJ/kg</u> (iii) $\boxed{\dot{m} = 5.68\ kg/s}$

Summer 2007 (2006-07 Academic Session, **Re-Sit**)

Question B1: (1): $\boxed{P_A - P_B = 34688\ \ N/m^2}$

Question B2: Head Loss : $\boxed{h_{loss} = 9.4\ m}$

Question B3 (i) $\boxed{\Delta P = P_2 - P_1 = 61.4(kPa)}$ (ii) $\boxed{m_1 = 0.03564\ \ (kg)}$

(iii) $\boxed{\Delta m = 0.00606(kg)}$

Question B4 (i) $\boxed{T_{exit} = 25^o C}$ (ii) $\boxed{\overline{V}_2 = 5.16\ \ m/s}$

Christmas 2006 (2006-07 Academic Session, End of Semester Paper)

Question B1: (1): $\boxed{Q = \left[\dfrac{2.g.h.\left(\dfrac{\rho_m}{\rho_w} - 1\right)}{1 - \left(\dfrac{A_2}{A_1}\right)^2}\right]^{1/2} .A_2}$ (2) $\boxed{Q = 0.029\ m^3/s}$

Question B2: Head Loss : $\boxed{h_{loss} = 9.4\ m}$

Question B3 (a) $\boxed{{}_1W_2 = -696\ kJ}$ (b) $\boxed{{}_1Q_2 = -696\ kJ}$

Question B4 (i) $\boxed{T_{exit} = 25^o C}$ (ii) $\boxed{\overline{V}_2 = 5.16\ \ m/s}$

Summer 2006 (2005-06 Academic Session, **Re-Sit**)

Question B1: (i): $\boxed{v_c = 7.004\ m/s}$ (ii) $\boxed{Q = 0.220\ m^3/s}$ (iii) $\boxed{\frac{P_B}{\rho g} = -4.5\ m}$

Question B2: (i) $\boxed{\Delta P = 61.4(kPa)}$ (ii) $\boxed{m_1 = 0.03564\ (kg)}$ (iii) $\boxed{\Delta m = 0.00606(kg)}$

Question B3:(1) $\boxed{V_2 = 0.0535\ m^3}$ (2) $\boxed{{}_1W_2 = -33.61\ kJ}$ (3) $\boxed{T_2 = 491.61\ K = 218.46\ {}^oC}$

Christmas 2005 (2005-06 Academic Session, End of Semester Paper)

Question B1: (i) $\boxed{Q = 1.45\ m^3/s}$ (ii): $\boxed{\frac{P_B}{\rho g} = -5.0m}$

Question B2: IDEAL GAS : $\boxed{v = 0.035711\ m^3/kg}$

TABLES $\boxed{v = 0.03279\ m^3/kg}$ (MORE ACCURATE)

Question B3 T_e = 28 °C, slightly “cold”

D. Timoney, November 2012