

ENGINEERING TRIPOS PART IB

**Paper 4: THERMOFLUID MECHANICS**

**ANSWERS**

- 1(b) (i)  $\frac{dT}{dr} = -\frac{H}{3\lambda}r$       (ii)  $\frac{H}{6\lambda}a^2$
- (c) (i) 28      (ii)  $3\tau$ , with  $\tau = \frac{2\rho ca^2}{3\lambda_{\text{argon}}Nu} \approx 238\text{s}$
- 2(a) (i) 3004kW    (ii) 1027kW    (iii) 0.340
- (b) (i) 4.63      (ii) 76°C
- (c) (i) 1555kW
- 3(a) (i)  $\text{CH}_4 + 3\text{O}_2 + 11.29\text{N}_2^* \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + \text{O}_2 + 11.29\text{N}_2^*$       (ii) 705MJ
- (b) (i)  $\text{CH}_4 + 1.5\text{O}_2 \rightarrow \text{CO} + 2\text{H}_2\text{O}$       (ii)  $\text{CO} + 0.5\text{O}_2 \rightarrow \text{CO}_2$   
 (iii) 517MJ, 283MJ
- (c) (i)  $\text{CH}_4 + 1.75\text{O}_2 + 6.583\text{N}_2^* \rightarrow 0.5\text{CO} + 0.5\text{CO}_2 + 2\text{H}_2\text{O} + 6.583\text{N}_2^*$   
 (ii) 659MJ
- 4(b) (ii)  $u_\theta = r \left[ \frac{\omega_2 + \omega_1}{2} + (\omega_2 - \omega_1) \frac{z}{h} \right]$
- 5(c) (i) 924Pa      (ii) Power  $\propto d^{-5}c_f$ ;  $c_f \approx \text{constant}$
- 6(a) (ii)  $p_p - p_a = \frac{1}{2}\rho V^2$
- (b) (i)  $p_p + \frac{1}{2}\rho \left(\frac{Q}{A}\right)^2$
- (c) (i)  $p_p = \frac{4W}{\pi D^2}$       (ii)  $Q^2 = \frac{c_0 - 4W/\pi D^2}{c_2 + \rho/2A^2}$