2012 Engineering Tripos 1A, Paper 1, Mechanical Engineering, Numerical answers

1 a) 11.8 ms^{-1}
b) ±2.5%
c) –

2 2.084 m^3s^{-1}

3 a) 19.81 ms^{-1}
b) 622 kW
c) 1.981 ms^{-1} , 294000 Nm^{-2} , –5.05, 1.00

4. a) 0.25 kW , 5
b) 0.8333 WK^{-1}

5. a) 521.3 K
b) 180.3 kJ kg^{-1}
c) –
d) –

6. a) –
b) $4\gamma/5$
c) $5\gamma/6$, 6/5

2012 - PART IA – Paper 1: Mechanical Engineering – Section B
Aylmer Johnson and Nathan Crilly

Q7
(a) The moment of momentum of a system is conserved about an axis when no external forces act so as to provide a torque about that axis (i.e. all external forces act through or parallel to the axis).

(b) $\frac{5}{8}\omega_1$ (c) $\sqrt{\frac{15}{8}\omega_1 l}$

Q8
(a) 6.12 m/s; 0.766 Rad
(b) Zero
(c) Downwards

Q9
(a) 10 Rad/s (counter-clockwise)
(b) 100 mm/s (left)

(c) $\frac{20}{\sqrt{3}}$N

Q10
(b) $b\alpha\left(1-e^{-t/T}\right)$
(c) $\lambda_2 \approx 3.78\lambda_1$

Q11
(a) $m_1 = m_2 = 1$ kg ; $k_2 = k_3 = 200$ N/m ; $k_1 = 100$ N/m
(b) $\omega_1 = 12$ Rad/s ; $\omega_2 = 23.6$ Rad/s
(c) $\omega = 20$ Rad/s
(d) At $\omega = 0$, $Y_1 = 0.05$, $Y_2 = 0.025$.

Q12
(a) $\frac{\omega_1}{2}$ (counter-clockwise)

(bi) $v_a = r\,\omega_1$ (right) ; v_b and v_c are of the same magnitude but rotated clockwise 120° and 240° respectively.

(bii) $\frac{\omega_1}{3}$ (clockwise)

(ci) $T_{arm(2)} = \frac{3}{2}\,T_{ring(1)}$

(cii) $T_{arm(2)} = 2\,T_{ring(1)}$