DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

UNIVERSITY EXAMINATIONS 2014/2015

FIRST YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE IN

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

SPH 2173 : PHYSICS FOR ENGINEERS I

DATE: 12TH FEBRUARY 2015 **TIME: 8.30AM – 10.30AM**

Some useful constants

(1) $g = 9.8 m.s^{-2}$

(2) Specific heat capacity of water $c_W = 4200 J.kg^{-1}K^{-1}$

(3) Specific heat capacity of copper $c_{Cu} = 400 J.kg^{-1}K^{-1}$

(4) Density of water $D = 1.0 X 10^3 kgm^{-3}$

(5) Universal gas constant $R = 8.31 J.mol^{-1}K^{-1}$

(6) $1 atm = 101.3 kPa$

(7) Stefan-Boltzmann constant $\sigma = 5.67 X 10^{-8} Wm^{-2}K^{-4}$

Answer question one and any other two questions

QUESTION ONE COMPULSORY **30 MARKS**

(a) Define the following terms.

(i) Instantaneous velocity

(ii) Vector

(iii) Angular speed

(iv) Tangential acceleration **(2 marks)**

(b) The displacement equation of a particle is given as $x(t) = (10t^2 - 8t - 3)m$

(i) Find the equation governing the velocity and acceleration of motion of the particle at any time t

(3 marks)

(ii) Calculate the average acceleration between $t = 2s$ and $t = 6s$ **(3 marks)**

(c) State in words Newton's second law for rotation of a rigid body about a fixed axis **(2 marks)**

(d) At $t = 0$ a flywheel is rotating at $50rpm$. A motor gives it a constant acceleration of $0.5rad.s^{-2}$ until it reaches $100rpm$ .the motor is then disconnected. How many revolutions are completed at $t = 20s$?

(3 marks)

(e) A mass of 150 kg is suspended from a wire whose length is 2m.The wire length increases to 2.02 m. If the diameter of the wire is 1.5mm, compute the Young`s modulus of the wire. **(4 marks)**

(f) An empty lorry of 10 tonnes is moving at 2m/s along a level track and collides with a loaded lorry of mass 20 tonnes at rest with brakes released .If the two couple together determine their common speed after collision. **(3 marks)**

(g) State and explain two factors that affect the rate of conduction of heat. **(4 marks)**

(h) State two conditions necessary for beats to occur **(2 marks)**

(i) The volume of a gas in a tube changed from 120 cm^3 to 180cm^3. If its original temperature was 123^0C, calculate its final temperature in degrees Celsius. **(3 marks)**

QUESTION TWO OPTIONAL **20 MARKS**

(a) Define the following terms

(i) Simple harmonic motion
(ii) Amplitude
(iii) Frequency **(3 marks)**

(b) A body of mass 5kg moves with S.H.M of amplitude of 3m and a period of ten seconds. Determine

(i) The frequency of the motion. **(1 marks)**

(ii) The force on the body at t = 2seconds. **(5 marks)**

(c) Derive the expression for rotational kinetic energy of a rigid body about a fixed axis **(2 marks)**

(d) The equation of a transverse wave in a string is given by $y = 4\pi \cos\left\{12.5\pi t - \frac{x}{0.25}\right\}$where y and x are in metres and t in seconds. Determine

(i) The frequency of the wave. **(2 marks)**

(ii) The velocity of propagation **(2 marks)**

(iii)The value of y when t = 2 and x =40. **(2 marks)**

(e) State three types of waves. **(3 marks)**

QUESTION THREE OPTIONAL **20 MARKS**

(a) Define the following terms.

(i) temperature

(ii) radiation

(iii) elasticity **(3 marks)**

(b) A copper cup of mass 0.3kg initially at 40^{o}C is filled with 0.2 kg of water at 130^{o}C. Determine the final temperature of the water and the copper cup after attaining thermal equilibrium assuming no heat loss. **(4 marks)**

(c) A rectangular block steel plate 40 cm by 60 cm by 90cm is heated in fire to a temperature of 100 degrees Celsius. Taking emissivity to be unity, determine the total rate of radiation of the heat energy.

(3 marks)

(d) Sketch the temperature time graph of ice as its heated slowly to steam. **(3 marks)**

(e) (i)Derive the Bernoulli's equation of an incompressible fluid and define as the symbols used

(4 marks)

(ii) Water at a speed of 12m/s is pumped through a pipe of 14cm in diameter to a smaller tap whose diameter is 5cm. Determine the speed of delivery of water from the tap. **(3 marks)**

QUESTION FOUR OPTIONAL **20 MARKS**

(a) State in words the principle the principle of rotational inertia of a rigid body about a fixed axis. Write down the mathematical expression **(3 marks)**

(b) A wheel whose moment of inertia is $45 kg.m^2$ is to be accelerated from 20 to $100 rpm$ in 10 seconds. What is the average power needed **(5 marks)**

(c) A wheel has a constant angular acceleration of $3.0 rad.s^{-2}$. During a certain $4.0 s$ interval, it turns through angle of $120 rad$. Assuming that the wheel starts from rest, how long is it in motion at the start of the $4.0 s$ interval **(4 marks)**

(d) An automobile crankshaft transfers energy from the engine to the axle at a rate of $100 hp = 74.6 kW$ when rotating at a speed of $1800 rpm$. What torque does the crankshaft deliver?

(4 marks)

(e) Under which condition the output of superposition of two waves with same amplitude and frequency is twice the amplitude of one of the waves? Prove it mathematically **(4 marks)**

QUESTION FIVE OPTIONAL **20 MARKS**

(a) State

(i). Newton`s second law of motion.

(ii). Hooke`s law.

(iii). Pascal principle.

(iv). Principle of conservation of energy. **(4 marks)**

(b))Three forces (200N,20^0) (400N,90^0) and (300N,$300^{0)}$ acts on a point ,determine the resultant of the three forces. **(4 marks)**

(c) Using dimensional analysis, find the dimensions of kinetic energy. **(3 marks)**

(d) The coordinates of a particle moving in the x – y plane is given as a function of time as $x = (t^3 + 6t)$ meters $y = (3t^3 + 8t)$ meters. Calculate

(i) The particle distance from the origin at t = 2 seconds. **(3 marks)**

(ii) The particle speed at t = 5 seconds. **(3 marks)**

(iii) The particle velocity at t= 2 seconds in the y direction. (**3 marks)**

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