

EXAMINATIONS 2018 / 2019

ARHOLIADAU 2018 / 2019

FACULTY OF: Architecture, Computing & Engineering

NAME OF COURSE/PROGRAMME: BEng Engineering Programmes

YEAR OR LEVEL: Level 4

NAME OF MODULE/UNIT/EXAM PAPER: Engineering Science 1

MODULE NO: M4X00385

DATE OF EXAMINATION:

EXAMINATION TIMES:

START TIME:

FINISH TIME:

TIME ALLOWED: 2 hours

INSTRUCTIONS TO CANDIDATES:

Answer **all** questions.

$g = 9.81\text{m/s}^2$

Give answers to 2.d.p.

You are allowed a scientific calculator and a dictionary.

1.

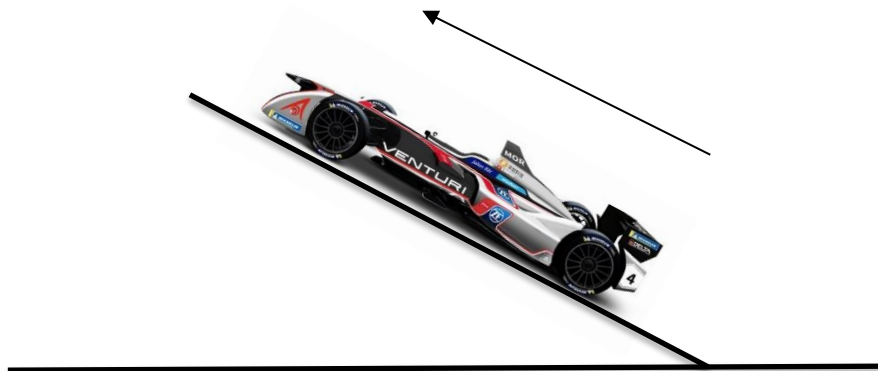
A formula e car performs a straight-line acceleration from 0 to 100km/h in 3 seconds. It then accelerates up to its top velocity of 225km/h in 10 seconds, when the brakes are immediately applied and it comes back to rest in 65m. Construct a velocity time graph [5 marks] and calculate:

- The rate of acceleration from 0-100km/h. [6 marks]
- The rate of acceleration from 100km/h to 225km/h. [5 marks]
- The braking time. [4 marks]
- And total displacement of the car. [8 marks]



Figure 1: FIA Formula E car.

2.



$$P = Fv$$

$$F = \mu R$$

At one circuit the Formula E car has to travel up an incline of 20° at a velocity of 140km/h. Given that the car has a mass of 888kg and that it is using 150kW of power, construct a forces diagram [5 marks] and calculate the coefficient of friction between the tyres and the incline. [12 marks]

3.



Figure 2: Electric motor

The rotor of the electric motor of a Formula E car, accelerates up to 20000rpm in 0.5 seconds, where it reaches its peak torque of 145Nm. Calculate:

- The mass moment of inertia of the rotor. [9 marks]
- The mass of the rotating parts. Given the rotor has a diameter of 260mm. [5 marks]
- The power developed at this rpm in kW. [3 marks]
- The maximum kinetic Energy of the rotating parts in kJ. [3 marks]

$$I = mk^2 \quad T = I\alpha$$

$$P = T\omega \quad KE = \frac{1}{2} I\omega^2$$

4.

A diving cylinder contains a volume of gas at a temperature of 35°C and a pressure of 200 bar. The temperature is reduced to 15°C, calculate the new pressure given the volume of gas has reduced by a fifth. [9 marks]

5.

A tapered pipe running full of oil, of density 885kg/m³ has a height difference of 420mm between the tapers. The start of the taper has a diameter of 75mm and at the end the diameter is 25mm, assuming there are no frictional losses calculate the flow rate given the pressure difference is 3.5kPa. [18 marks]

$$d_1^2 v_1 = d_2^2 v_2 \quad gh_1 + \frac{p_1}{\rho} + \frac{v_1^2}{2} = gh_2 + \frac{p_2}{\rho} + \frac{v_2^2}{2}$$

THIS QUESTION HAS A MULTIPLE CHOICE ANSWER, WRITE DOWN ONE ANSWER ONLY ON YOUR ANSWER BOOKLET:

- a. 4.51 m³/s b. 0.00045m³/s c. 0.04m³/s d. 0.40m³/s

6.

A composite panel of dimensions 800mm by 450mm is situated between an engine bay of temperature 62°C and a passenger compartment of temperature 22°C. The composite consists of an inner layer of glass fibre weave of thickness 3mm and thermal conductivity 0.05W/mK and outer layers of epoxy resin of thickness 1.5mm and thermal conductivity 280 W/mK. Calculate the steady heat flow from the engine bay to the passenger compartment.

[12 Marks]

$$\frac{1}{U} = \frac{1}{U_1} + \frac{1}{U_2} + \frac{1}{U_3} \quad Q = UA(T_1 - T_2)$$

THIS QUESTION HAS A MULTIPLE CHOICE ANSWER, WRITE DOWN ONE ANSWER ONLY ON YOUR ANSWER BOOKLET:

a. 240.05W

b. 240.05kW

c. 0.86W

d. 86kW

7.

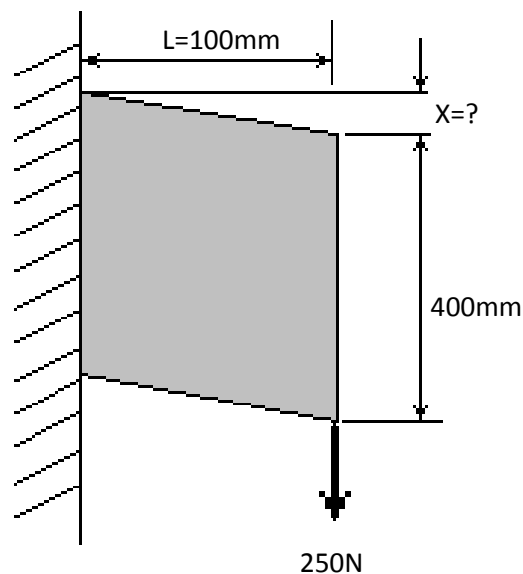


Figure 3.

Figure 3 shows an experiment to determine the modulus of rigidity of a sample of material, a rectangular block of the material, measuring 400 x 100 x 25mm, was firmly fastened, so that it projected a distance of 100mm from a vertical wall. It was found that when a downward load of 250N was applied to the free vertical edge, the experimental value of the modulus of rigidity of this material sample was found to be 44GN/m². Calculate the vertical deflection, x, of the sample. [13 marks]

$$G = \frac{\tau}{\gamma}$$

8.

A drive shaft has an annular cross section with an outer diameter of 150mm. It is to be subjected to a torque of 1200Nm, given that the maximum shear stress must not exceed 65MN/m², calculate the shaft inner diameter to 3dp.

[10 marks]

$$J = \frac{\pi(D^4 - d^4)}{32} \qquad \frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$

EXAMINATIONS 2016 / 2017

ARHOLIADAU 2016 / 2017

FACULTY OF: Architecture, Computing & Engineering

NAME OF COURSE/PROGRAMME: BEng Engineering Programmes

YEAR OR LEVEL: Level 4

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TIME ALLOWED: 2 hours

INSTRUCTIONS TO CANDIDATES:

Answer **all** questions.

$g = 9.81\text{m/s}^2$

Give answers to 2.d.p.

You are allowed a scientific calculator and a dictionary.

1.

A life boat like the one in Figure 1, on a calm day, can accelerate up to its top speed of with a rate of 1.16m/s^2 . It can return to rest once the engines have shut off, with a deceleration of 3.22m/s^2 , the total movement taking just 15s.

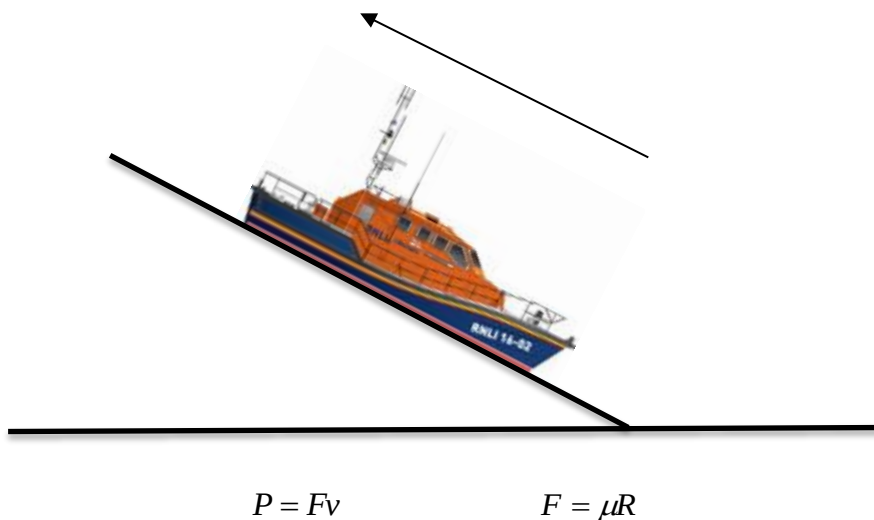
Construct a velocity time graph [3 marks] and calculate

- The maximum velocity of the boat. [12 marks]
- And the displacement of the boat in this time. [3 marks]



Figure 1: Life boat

2.



To haul the life boat back into its launch house, a 80kW winch is used. The launch ramp has a gradient of 1 in 4 measured along the slope. Given that the life boat weighs 32 tonnes and there is a coefficient of friction of 0.2 between the ramp and the boat, construct a forces diagram [5 marks] and calculate the constant velocity the boat travels up the ramp. [12 marks]

3.



Figure 2

The Life boat is powered by two Caterpillar C18 engines like the one in Figure 2. Given the rotating parts are considered to have a radius of gyration of 600mm, and the engine can achieve its maximum torque of 4114Nm at 1600rpm within 8 seconds of starting, Calculate:

- The mass moment of inertia of the rotating parts. [8 marks]
- The mass of the rotating parts. [4 marks]
- The power developed at this rpm in kW. [3 marks]
- The torque developed when the engine is at maximum power of 746.5kW, which occurs at 1800rpm. [4 marks]
- The maximum kinetic Energy of the rotating parts in MJ. [3 marks]

$$I = mk^2$$

$$T = I\alpha$$

$$P = T\omega$$

$$KE = \frac{1}{2} I\omega^2$$

4.

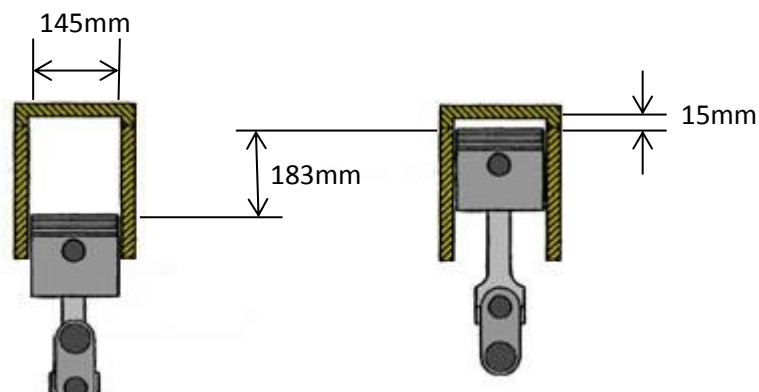


Figure 3

The large single cylinder engine has dimensions of those shown in Figure 2. At the commencement of the compression stroke the pressure is 1.013bar. Given that the pressure has increased to 38bar at a temperature of 655°C, calculate the temperature before combustion. [14 marks]

5.

A venturi meter is used to measure the flow of oil, of density 885kg/m^3 in a horizontal pipe of 50mm diameter. If the throat of the meter is 25mm in diameter, what will the flow rate of the oil be if the pressure difference between the manometers is 3.5kPa? Assume there are no frictional losses.

[12 marks]

$$H = \frac{(p_1 - p_2)}{\rho g} = \frac{(v_2^2 - v_1^2)}{2g} \qquad Q = A_1 \sqrt{\frac{(2gH)}{[(A_1 / A_2)^2 - 1]}}$$

THIS QUESTION HAS A MULTIPLE CHOICE ANSWER, CIRCLE ONE ONLY:

- a. $0.0014\text{m}^3/\text{s}$ b. $0.00045\text{m}^3/\text{s}$ c. $0.081\text{m}^3/\text{s}$ d. $0.40\text{m}^3/\text{s}$

6.

Figure 4 is that of an air cooled single cylinder engine. A similar engine can be considered to have 8 cooling fins, with an inner and outer radius of 70mm and 80mm respectively. If the engine has a radiation heat flow value of 1.2kW, and the atmospheric temperature is 288K. Calculate the average fin temperature of the engine. Assume an emissivity value of 0.70. [15 marks]



Figure 4.

$$Q = 56.7 \varepsilon A \left[\left(\frac{T_2}{1000} \right)^4 - \left(\frac{T_1}{1000} \right)^4 \right]$$

THIS QUESTION HAS A MULTIPLE CHOICE ANSWER, CIRCLE ONE ONLY:

- a. 1265.19K b. 4480.86K c. 2250.00K d. 800.20K

7.

An experimental section of steel bar with diameter 60mm, is simply supported at each end and undergoes a bending test. When loaded the bar is observed to have a radius of curvature of 1850m. Given that the steel chassis has a Young's modulus of elasticity of 95GN/m², calculate the maximum stress and the bending moment experienced by the beam. [13 marks]

$$I = \frac{\pi D^4}{64} \qquad \frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

8.

A solid cross section drive shaft has a diameter of 40mm. It is to be subjected to a torque of 560Nm and has a Modulus of rigidity of 110GN/m². Given that the shaft is 800mm long calculate the maximum shear stress and the angle of twist in degrees. [16 marks]

$$J = \frac{\pi D^4}{32} \qquad \frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$

EXAMINATIONS 2015 / 2016

ARHOLIADAU 2015 / 2016

FACULTY OF: Architecture, Computing & Engineering

NAME OF COURSE/PROGRAMME: BEng Engineering Programmes

YEAR OR LEVEL: Level 4

NAME OF MODULE/UNIT/EXAM PAPER: Engineering Science 1

MODULE NO: M1X8801 & M4X00385

DATE OF EXAMINATION:

EXAMINATION TIMES:

START TIME:

FINISH TIME:

TIME ALLOWED: 2 hours

INSTRUCTIONS TO CANDIDATES:

Answer **all** questions.

$g = 9.81\text{m/s}^2$

Give answers to 2.d.p.

You are allowed a scientific calculator and a dictionary.

1. A Ducati Panigale motorcycle, can accelerate up to 96.6km/h in 2.7 seconds, it can then reaches 215.4km/h after a further 7.7 seconds. It can be brought back to rest in 36m. Sketch a velocity-time graph [5 marks] and calculate:
 - a. The rate of acceleration to 96.6km/h, [5 marks]
 - b. The rate of acceleration from 96.6-215.4km/h, [4 marks]
 - c. The total combined distance travelled for acceleration and deceleration. [8 marks]
 - d. The total time taken for both movements. [6 marks]

2.

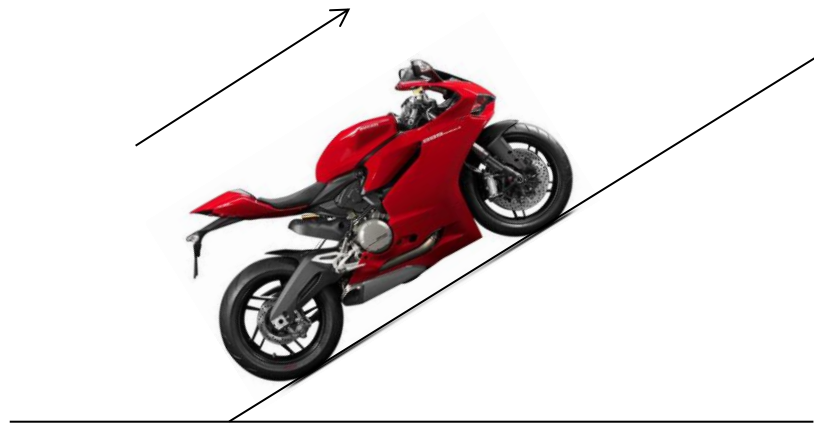


Figure 1.

Figure 1 above shows the Ducati Panigale driving up an incline measuring 1 in 4.5 measured along the slope. There the coefficient of friction between the tyres and the road surface of 0.35 and the mass of the Panigale is 193kg. Given that the power developed by the engine is 109kW, construct a forces diagram [5 marks] calculate the velocity of the Panigale. [14 marks]

$$P = F.v$$

$$F = \mu R_n$$

3.

The Ducati Panigale develops it maximum Torque of 99Nm at 9000rpm, given that the engine can achieve this speed in 0.95s, and that the rotating parts of the engine can be assumed to have a radius of gyration of 280mm, calculate:

- a. The mass of the rotating components, [12 marks]
- b. The power developed by the engine at the speed. [2 marks]
- c. The torque developed at 10750rpm which is when the Panigale achieves its maximum power of 109kW. [5 marks]

$$P = T\omega \quad T = I\alpha \quad I = mk^2 \quad k^2 = \frac{d^2}{8}$$

4.

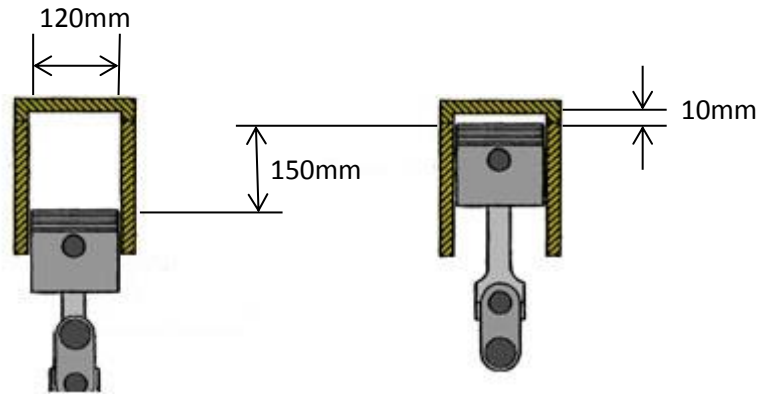


Figure 2

The large single cylinder engine has dimensions of those shown in Figure 2. At the commencement of the compression stroke the pressure is 1.2bar. Given that the pressure has increased to 32bar at a temperature of 287°C, calculate:

- The compression ratio, [11 marks]
- The temperature before combustion. [6 marks]

5.

Beer, of density 1000kg/m³, flows from a barrel, similar to that in figure 3, via a horizontal tap. The diameter of the tap at the entrance is 40mm and the velocity of the beer entering the tap is 0.75m/s. Given that the exit pressure is 1.013bar and the diameter of the tap is 20mm, calculate the pressure inside the barrel. [11 marks]



Figure 3

$$d_1^2 v_1 = d_2^2 v_2 \quad gh_1 + \frac{p_1}{\rho} + \frac{v_1^2}{2} = gh_2 + \frac{p_2}{\rho} + \frac{v_2^2}{2}$$

THIS QUESTION HAS A MULTIPLE CHOICE ANSWER, CIRCLE ONE ONLY:

- b. 105518.75bar b. 1.06bar c. 105.51bar d. 10.5.5bar

6.

A composite silicon hose as shown in figure 4, comprises of an inner and outer layer of silicon of thermal conductivity 191 W/Mk and thickness 1.5mm, and a middle layer of nylon weave with a thermal conductivity of 5W/mK and thickness 3.5mm. The hose runs through an engine bay, has an outer diameter of 40mm and is 70mm long. Given that the fluid within the hose is of a temperature of 80°C and the engine bay temperature is 38°C, Calculate the heat transfer.

[15 marks]

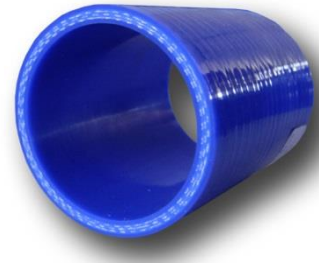


Figure 5.

$$\frac{1}{U} = \frac{1}{U_a} + \frac{1}{U_b} + \frac{1}{U_c}$$

$$Q = -UA(T_1 - T_2)$$

THIS QUESTION HAS A MULTIPLE CHOICE ANSWER, CIRCLE ONE ONLY:

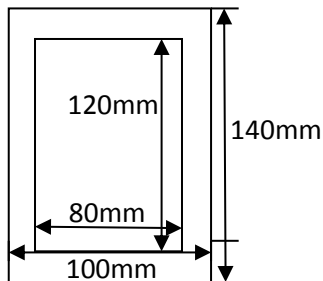
a. 521.93kW

b. 521.93W

c. 51.6.2kW

d. 516.2W

7.



A section of chassis in a vehicle can be modelled as box section with dimensions as seen in the diagram left. The beam experiences a bending moment of 4000Nm. Given that the material of the chassis has a Young's modulus of elasticity of 205GN/m², calculate the maximum stress and the radius of curvature of the beam.

[15 marks]

$$I = \frac{BD^3}{12} - \frac{bd^3}{12}$$

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

8.

A drive shaft has an annular cross section with an outer diameter of 50mm. It is to be subjected to a torque of 40Nm, given that the maximum shear stress must not exceed 52MN/m², calculate the shaft inner diameter to 4dp.

[13 marks]

$$J = \frac{\pi(D^4 - d^4)}{32}$$

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$

EXAMINATIONS 2014 / 2015

ARHOLIADAU 2014 / 2015

FACULTY OF: Architecture, Computing & Engineering

NAME OF COURSE/PROGRAMME: BEng Engineering Programmes

YEAR OR LEVEL: Level 4

NAME OF MODULE/UNIT/EXAM PAPER: Engineering Science 1

MODULE NO: M1X8801 & M4X00385

DATE OF EXAMINATION: Wednesday 21st January 2015

EXAMINATION TIMES:

START TIME: 11:00

FINISH TIME: 13:00

TIME ALLOWED: 2 hours

INSTRUCTIONS TO CANDIDATES:

Answer **all** questions.

$g = 9.81\text{m/s}^2$

Give answers to 2.d.p.

Name:.....

1.

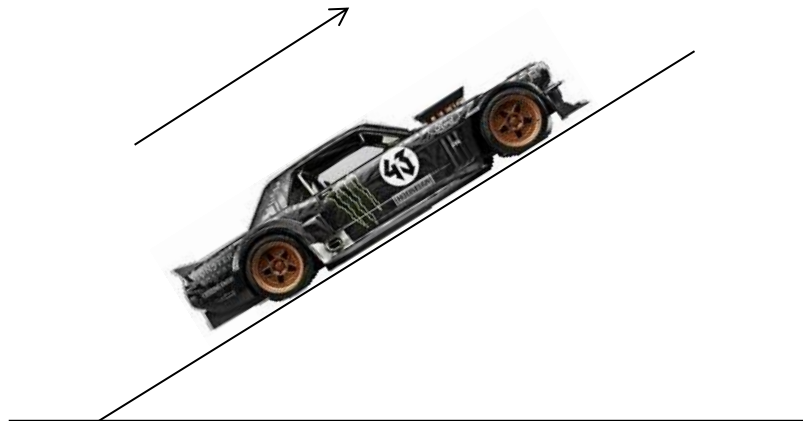


Figure 1.

Figure 1 above shows the Hoonicorn driving up an incline measuring 1 in 3.5 measured along the slope at 220km/h. Given that there is a constant resistance to motion of the order of 1550N and that the power developed by the engine is 450kW, construct a forces diagram on Figure 1 and calculate the mass of the Hoonicorn. [16 marks]

When travelling on a level surface at 220km/h with the wheels at the point of spinning, the Hoonicorn only needs 250kW, calculate the coefficient of friction between the tyres and the surface. [5 marks]

$$P = F.v$$

$$F = \mu R_n$$

2.

A factory contains a flywheel similar to that in Figure 2, which has a mass of 8 tonnes. Given a torque of 4.2kNm the flywheel can accelerate up to 300rpm from rest in 45s. Calculate the radius and the kinetic energy of the flywheel. [20 marks]



Figure 2

$$T = I\alpha \quad I = mk^2 \quad k^2 = \frac{d^2}{8}$$

3.



Figure 3

A fully inflated hot air balloon (Figure 3) starts at an atmospheric pressure of 1.013bar and temperature of 18°C. Given the volume of the balloon has increased by a quarter, calculate the new pressure, in bar, when the temperature has been raised to 45°C. (Consider the balloon as a closed system for these purposes) [10 marks]

4.



Figure 4

Water travels in a horizontal fire hose (Figure 4) of diameter 80mm at a velocity of 4m/s, and a pressure of 20 bar. Given that the water exits the nozzle to atmospheric pressure of 1.013bar calculate the radius of the nozzle.

$$(\rho = 1000 \text{ kg / m}^3)$$

[12 marks]

$$d_1^2 v_1 = d_2^2 v_2$$

$$gh_1 + \frac{p_1}{\rho} + \frac{v_1^2}{2} = gh_2 + \frac{p_2}{\rho} + \frac{v_2^2}{2}$$

THIS QUESTION HAS A MULTIPLE CHOICE ANSWER, CIRCLE ONE ONLY:

a. 0.01m

b. 0.02m

c. 0.025m

d. 0.04m

5.

Figure 5 shows convection of a liquid in a sauce pan, the bottom of the pan is 200°C and the fluid is 30°C. Given that the pan has a radius of 100mm, and the convective heat transfer coefficient for this scenario is 650W/m²K, calculate the heat transfer. [5 marks]



Figure 5.

THIS QUESTION HAS A MULTIPLE CHOICE ANSWER, CIRCLE ONE ONLY:

- a. 867.86W b. 17357.29W c. 8678.65W d. 3471.46w

6.



Figure 6

The diving board in figure 6 experiences a force of 735N applied to the free vertical end which has dimensions 500mm wide by 80mm deep. A deflection of 68mm is observed. Given the diving board is 2m long calculate the modulus of rigidity for the diving board material. [12 marks]

$$G = \frac{\tau}{\gamma}$$

7.

A drive shaft with annular cross section is 0.65m long. When the shaft experiences a torque of 5.4kNm, the angle of twist observed is 0.25°. Given that the modulus of rigidity for the material is 195GN/m² and the inner diameter of the shaft is 35mm, calculate the outer diameter and the shear stress of the drive shaft. [14 marks]

$$J = \frac{\pi(D^4 - d^4)}{32}$$

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$



SWANSEA METROPOLITAN UNIVERSITY
PRIFYSGOL FETROPOLITAN ABERTAWE

Faculty of Applied Design and Engineering

School of Automotive Engineering

BEng Motorsport/ Automotive/ Motorcycle/Mechanical & Manufacturing Engineering

Year 1

Engineering Science

Test 1

Wednesday 29th January 2014

11 am

Instructions to candidates:

There are four questions in this paper, answer all questions.

Give all answers to 2.d.p.

Name:.....

1.



A Jaguar XC75 car has a mass of 1350kg. The car can accelerate uniformly from rest up to 100km/h in 3.4 seconds, from 100km/h to 160km/h in 2.1 seconds and finally from 160km/h to 300km/h in 10.2 seconds. Draw a velocity time graph [4 marks] and calculate:

- a. The acceleration up to 100km/h. [5 marks]
- b. The total distance covered. [18 marks]
- c. The maximum kinetic energy of the XC75. [3 marks]

The XC75 micro turbine motor develops 1600Nm of torque and generates the equivalent of 140kW of power.

- d. the angular velocity of the turbine. [4 marks]

Given that the rotating parts of the turbine can be accelerated from rest to this speed in 3.4 seconds, and that they have a radius of gyration of 0.25m calculate

- e. the mass of the rotating parts. [12 marks]
- f. The rotary energy of the system. [3 marks]

$$KE = \frac{1}{2}mv^2 \quad P = T\omega \quad T = I\alpha \quad I = mk^2 \quad KE = \frac{1}{2}I\omega^2$$

2.

a. The Jaguar of mass 1350kg and power 580kW is driven on a level road at its maximum velocity of 300km/h, calculate the co efficient of friction between the road and car tyres. [7 marks]

b. The car is now driven up Constitution Hill at a constant speed, given that the hill is inclined at 1 in 5 measured along the slope, and that the frictional force between the tyres and the road is 550N, construct a basic forces diagram [3 marks] and calculate the velocity. [13 marks]

$$P = Fv$$

$$F = \mu R = \mu mg$$

3. Gasses in a single cylinder engine occupy a volume of $35 \times 10^{-5} \text{ m}^3$ at a pressure of $15 \times 10^5 \text{ Pa}$ immediately after combustion. Following expansion the new pressure is $1.8 \times 10^5 \text{ Pa}$, given that the temperature is kept at a constant throughout the process, calculate the volume at the end of expansion. Given that the bore of the cylinder is 0.12m calculate the engine stroke. [13 marks]

4. A square section of pipe has the cross sectional dimensions 0.6x 0.6m and carries fluid of density 850 kg/m^3 at a velocity of 5m/s. At another section of pipe the cross section 18m lower the cross section dimensions have reduced to 0.4x0.4m. Calculate

a. the velocity at the lower end of the pipe. [6 marks]

b. the difference in pressure between the two sections of pipe. [6 marks]

c. the quantity of flow. [4 marks]

$$A_1 v_1 = A_2 v_2 \quad gh_1 + \frac{p_1}{\rho} + \frac{v_1^2}{2} = gh_2 + \frac{p_2}{\rho} + \frac{v_2^2}{2} \quad Q = Av$$



SWANSEA METROPOLITAN UNIVERSITY
PRIFYSGOL FETROPOLITAN ABERTAWE

Faculty of Applied Design and Engineering

School of Automotive Engineering

BEng Automotive/Motorsport/Motorcycle/ Mechanical Manufacturing Engineering

Year 1

Engineering Science

Phase Test 2

Wednesday 7th May 2014

11am

Instructions to candidates:

Answer all questions in the paper giving all answers to 2.d.p where appropriate.

Name:.....

Course:.....

1.

A titanium rod of length 0.3m has a Young's modulus value of 110.3GN/m². When a direct force of 450kN is applied to the end of the rod the extension is found to be 0.08mm. Calculate:

- a. the direct strain, [5 marks]
- b. the direct stress, [4 marks]
- c. the diameter of the rod. [9 marks]

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

2.

Figure 1 shows the cross section dimensions of a gear linkage made from aluminium with a Young's modulus of elasticity of 69GN/m². When a bending moment is applied the radius of curvature of the linkage is 750m. Calculate:

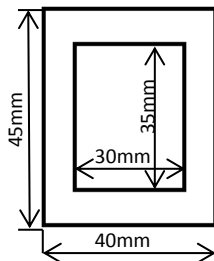


Figure 1.

$$I = \frac{BD^3}{12} - \frac{bd^3}{12} \quad \frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

- a. the second moment of area, [7 marks]
- b. the stress, [10 marks]
- c. the bending moment for the linkage. [4 marks]

3.

A drive shaft of length 250mm is manufactured from carbon fiber that has a modulus of rigidity of 41.4GN/m², is subjected to a turning moment of 450Nm. Given the shaft has a hollow cross section where inside diameter is 110mm and the outside diameter is 130mm. Calculate:

- a. the polar second moment of area, [4 marks]
- b. the angle of twist in degrees, [6 marks]
- c. the shear stress of the drive shaft. [8 marks]

$$J = \frac{\pi(D^4 - d^4)}{32}$$

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$

.....

4.

A rubber engine mount of circular cross section has a diameter of 80mm and subjected to a force of 100N. Given that the modulus of rigidity is 6MN/m², calculate:

- the shear stress, [7 marks]
- the shear strain of the engine mount. [4 marks]

$$G = \frac{\tau}{\gamma}$$

5.



Figure 2

A 5 cylinder radial engine similar to Figure 2, has 15 cooling fins on each cylinder each one having an inner diameter of 130mm and an outer diameter of 150mm. Given that the heat transfer of the engine is equivalent to 20kW, 3/5 of this being through radiation, calculate the emissivity value of the heat transfer, when the engine is of a temperature 150°C and the atmospheric temperature is 25°C.

[17 marks]

The other 2/5 of the heat transfer is through conduction given that the thermal conductivity for the cylinders' is 43W/mK, calculate the thickness of the fins. (Hint: find the heat transfer for 1 fin first).

[7 marks]

$$Q = 56.7 \varepsilon A \left[\left(\frac{T_2}{1000} \right)^4 - \left(\frac{T_1}{1000} \right)^4 \right]$$

$$Q = \frac{-kA(T_2 - T_1)}{x}$$



SWANSEA METROPOLITAN UNIVERSITY
PRIFYSGOL FETROPOLITAN ABERTAWE

Faculty of Applied Design and Engineering

School of Automotive Engineering

BEng Motorsport/ Automotive/ Motorcycle/Manufacturing Engineering

Year 1

Engineering Science

Test 1

Tuesday 29th January 2013

9 am

Instructions to candidates:

There are four questions in this paper, answer all questions.

Name:.....

1.



A Citroen DS3 WRC car and occupants of have a combined mass of 1360kg. The car can accelerate uniformly from rest up to 96.6km/h in 3 seconds. The DS3 maintains this speed for 15 seconds, when the brakes are then applied and the car comes to rest in 8 seconds. Draw a velocity time graph and calculate:

- a. The maximum acceleration. [8 marks]
- b. The total distance covered. [4 marks]
- c. The maximum kinetic energy of the DS3. [4 marks]

The DS3 generates 223.7kW of power. Calculate:

- d. The force needed to accelerate the car up to 96.6km/h. [4 marks]
- e. The work done in accelerating the DS3 to its maximum velocity. [6 marks]

The Citroen DS3 develops 350Nm of torque at 3250rpm. Given that the rotating parts of the engine can be accelerated from rest to this speed in 3 seconds, and that they have a radius of gyration of 0.9m calculate

- f. the weight of the rotating engine components for the DS3 and
- g. the rotary energy of the system.

[17 marks]

$$KE = \frac{1}{2}mv^2 \quad P = F.v \quad W.D = F.s \quad T = I\alpha \quad I = mk^2 \quad KE = \frac{1}{2}I\omega^2$$

2.

The Citroen of mass 1265kg is now driven up Mount Pleasant hill at a constant speed of 96.6km/h, given that the hill is inclined at 1 in 4 measured along the slope, and that there is a coefficient of friction between the tyres and the road of 0.3, construct a basic forces diagram [3 marks] and calculate the power needed from the engine [10 marks]. What is the angle of the slope in degrees? [2 marks].

$$P = Fv$$

$$F = \mu R = \mu mg$$

3. A single cylinder engine has a bore and stroke of 0.12m and 0.16m respectively and a clearance volume of $2.26 \times 10^{-4} \text{m}^3$. Calculate the compression ratio [7 marks]. Given that the atmospheric pressure and temperature is $1.013 \times 10^5 \text{N/m}^2$ and 15°C respectively, calculate the pressure at the end of compression when the new temperature is 120°C [9 marks].

4. A section of horizontal tube full of water of density 1000kg/m^3 tapers from 0.2m to 0.08m in diameter. Given that the pressure in the wider end of the pipe is 225kPa and at the narrow end is 150kPa, calculate the velocities at each end of the pipe. [15 marks]

$$d_1^2 v_1 = d_2^2 v_2 \qquad gh_1 + \frac{p_1}{\rho} + \frac{v_1^2}{2} = gh_2 + \frac{p_2}{\rho} + \frac{v_2^2}{2}$$



SWANSEA METROPOLITAN UNIVERSITY
PRIFYSGOL FETROPOLITAN ABERTAWE

Faculty of Applied Design and Engineering

School of Automotive Engineering

BEng Automotive/Motorsport/Motorcycle/ Mechanical Engineering

Year 1

Engineering Science

Phase Test 2

Tuesday 14th May 2013

9am

Instructions to candidates:

There are four questions in this paper, answer all questions.

Name:.....

Course:.....

1.

A 100N load is added to the end of circular cross section steel rod that has a length of 0.3m and a diameter of 0.025m. The steel has a Young's modulus value of 210GN/m²; calculate the stress and extension of the rod. [18marks]

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

2.

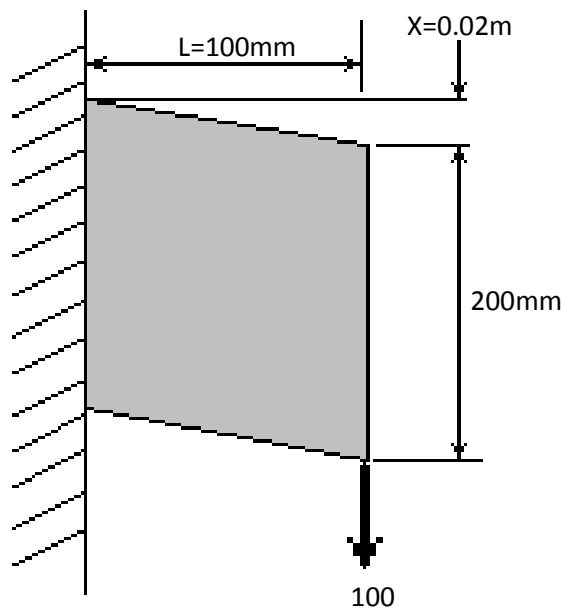


Figure 1.

Figure 1 shows an experiment to determine the modulus of rigidity of a sample of rubber, a rectangular block of the material, measuring 200 x 100 x 20mm, was firmly fastened, so that it projected a distance of 100mm from a vertical wall. It was found that when a downward load of 100N was applied to the free vertical edge, a vertical deflection of 0.02mm was obtained as shown. Determine the experimental value of the modulus of rigidity of this rubber sample. [12 marks]

$$G = \frac{\tau}{\gamma}$$

3.

A cross member of length 0.80m is supported at each end and has point loads of 650N and 250N at 0.3m and 0.4m respectively from one end. Calculate the reaction forces at the supports.

[10 marks]

Figure 2 shows the dimensions of the cross section of the chassis member made from titanium with a Young's modulus of elasticity of 120GN/m². A bending moment of 300Nm is subjected to the beam, calculate the radius of curvature and the stress of the beam.

[15 marks]

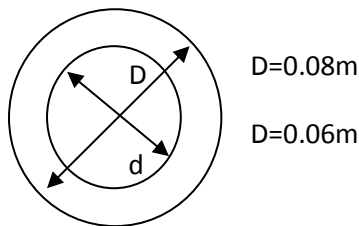


Figure 2

$$I = \frac{\pi}{64} [D^4 - d^4] \quad \frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

4.

If a drive shaft 0.8m long is to be subjected to a torque of 2.2kNm and the maximum shearing stress must not exceed 40MN/m², calculate the solid shaft diameter required to satisfy these conditions. Calculate the angle of twist in degrees given G=85GN/m².

[20 marks]

$$J = \frac{\pi D^4}{32}$$

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$



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Faculty of Applied Design and Engineering

School of Automotive Engineering

BEng Motorsport/ Automotive/ Motorcycle/Manufacturing Engineering

Year 1

Engineering Science

Test 1

Tuesday 4th September 2012

2 pm

Instructions to candidates:

There are Three questions in this paper, answer all questions.

Name:.....

1.

A crank shaft of mass 2kg is accelerated uniformly from rest to a maximum angular velocity of 3000rpm in 10 seconds. The crank shaft has a radius of gyration of 0.05m. Calculate:

- The maximum angular velocity in rad/s. [1 mark]
- The angular acceleration. [4 marks]
- The number of whole revolutions turned through in the acceleration. [5 marks]
- The moment of inertia of the crank shaft. [3 marks]
- The kinetic energy of the system. [3 marks]
- Given that the crank shaft web's have a radius of 0.08m calculate the linear velocity and acceleration of a point on the tip of these webs. [6 marks]

Given that the crank shaft moves a piston and connecting rod assembly of mass 0.35kg with simple harmonic motion through a stroke of 0.05m, calculate:

- The periodic time of the motion, [3 marks]
- The maximum acceleration, [3 marks]
- The maximum force on the assembly. [3 marks]

$$I = mk^2 \quad KE = \frac{1}{2} I \omega^2 \quad v = r \omega \quad a = r \alpha$$

2.

Abi makes 5 students pull her car of 1250kg up Mount Pleasant hill at a speed of 1.5m/s, given that the hill is inclined at 1 in 5 measured along the slope, and that there is a constant frictional resistance of 150N to the motion, construct a basic forces diagram [3 marks] and calculate the power generated but the students [7 marks]. How much power does one student generate? [2 marks] What is the angle of the slope in degrees? [2 marks].

The car is then pulled along a level surface with the wheels locked by just 3 students at the same speed. Given the power of each student remains unchanged, calculate the coefficient of friction between the car and the surface.

$$P = Fv \quad F = \mu R = \mu mg$$

3.



A balloon at initial atmospheric pressure of $1.013 \times 10^5 \text{ N/m}^2$ and temperature 290K is observed to have a volume of 0.1 m^3 . When moved into a hot room having a temperature of 315K the volume is observed to have doubled. Calculate the new pressure of the balloon.

While the balloon remains in the hot room, it volume is decreased back to its original value, calculate the new pressure.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$



Faculty of Applied Design and Engineering

School of Automotive Engineering

BEng Automotive/Motorsport/Motorcycle/ Mechanical Engineering

Year 1

Engineering Science

Phase Test 2

Wednesday 5th September 2012

2pm

Instructions to candidates:

There are five questions in this paper, answer all questions.

Name:.....

Course:.....

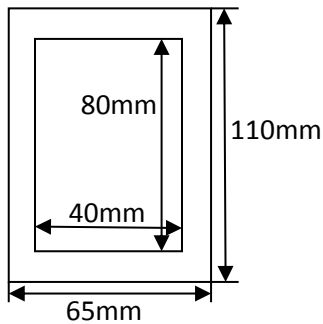
1.



The elastic surface of a trampoline is held to the frame with 20 steel bolts. Given the maximum shear stress of the steel bolts is 120MN/m^2 and the maximum estimated force on the trampoline is 150kN , calculate the diameter needed for the bolts. [12 marks]

$$\tau = \frac{F}{A}$$

2.



A single sided swing arm for a motorcycle can be modelled as box section with dimensions as seen in the diagram left. When the beam experiences full load it is observed to have a radius of curvature of 620m . Given that the material of the swing arm has a Young's modulus of elasticity of 210GN/m^2 , calculate the maximum stress and the bending moment experienced by the beam.

[15 marks]

$$I = \frac{BD^3}{12} - \frac{bd^3}{12}$$

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

3.

An anti roll bar of diameter 40mm experiences a maximum torque of 4.8kNm which results in a twist of 3.5° . The anti roll bar has an active length of 0.55m and the modulus of rigidity of spring steel is of the order of 90GN/m^2 . Calculate:

- The polar moment of area, J . [3 marks]
- The maximum shear stress on the anti roll bar. [10 marks]



$$J = \frac{\pi D^4}{32}$$

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$

4.



A twin cylinder engine has 20 cooling fins per cylinder, each fin having an outer diameter of 150mm and an inner diameter of 100mm. If the engine has an average fin temperature of 600K, calculate the heat flow from the engine through radiation if the atmospheric temperature is 288K. Assume an emissivity value of 0.70.

$$Q = 56.7 \varepsilon A \left[\left(\frac{T_2}{1000} \right)^4 - \left(\frac{T_1}{1000} \right)^4 \right]$$

5.

Beer flows through a horizontal tap at 1 m/s which tapers from 60mm to 30mm. The density of beer is 998kg/m³, calculate:

- The quantity of flow, Q.
- The velocity of the beer at the narrow end of the tap.
- The change in pressure between the two ends of the pipe.