PART A / *BAHAGIAN A*

(1). (a). Define safety factor with an equation

Takrifkan faktor keselamatan dengan satu persamaan.

(2 marks/*markah)*

(b). An 18-m-long steel wire of 5-mm diameter will be used in the manufacture of a prestressed concrete beam. It is observed that the wire stretches 45 mm when a tensile force **P** is applied. Knowing that *E* = 200 GPa, determine (*a*) the magnitude of the force **P**, (*b*) the corresponding normal stress in the wire.

*Suatu wayar keluli mempunyai panjang 18m dan diameter 5mm bakal digunakan dalam pembuatan rasuk konkrit prategasan. Daripada pemerhatian, wayar tersebut diregang sepanjang 45 mm apabila sesuatu daya tegangan **P** dikenakan. Dengan mengetahui E = 200 GPa, tentukan (a) magnitud daya **P**, (b) tegasan normal dalam wayar tersebut.*

(10 marks/*markah)*

(c). A nylon thread is subjected to a 8.5-N tension force. Knowing that E = 3.3 GPa and the length of the thread increases by 1.1% (ε=0.011), calculate:

Suatu benang nilon dikenakan daya tegangan sebanyak 8.5-N. Diketahui bahawa E = 3.3 GPa dan Panjang benang tersebut bertambah sebanyak 1.1% (ε=0.011), kirakan:

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(i) The stress in the thread
Tegasan benang tersebut

(4 marks/*markah)*

(ii). The diameter of the thread
Diameter benang tersebut

(4 marks/*markah)*

(2). (a). A solid bar of circular section has diameter d = 35.5 mm, length L = 1.5 m, and shear modulus of elasticity G = 85 GPa. The bar is subjected to torque T acting at the ends.

Bar pepejal berkeratan bulat mempunyai diameter d = 35.5 mm, panjang L = 1.5 m, dan modulus keanjalan ricih G = 85 GPa. Bar tertakluk kepada tork T bertindak pada kedua-dua hujung.

(i) If the torques have magnitude T = 350 N.m, compute
Jika tork mempunyai magnitud T = 350 N.m, hitung

(a) the maximum shear stress in the bar and
tegasan ricih maksimum dalam bar dan

(3 marks/markah)

(b) the angle of twist between the ends.
sudut putaran antara hujungnya.

(5 marks/markah)

(ii) If the allowable shear stress is 35 MPa and the allowable angle of twist is 2^o, calculate the maximum permissible torque.

Jika tegasan ricih yang dibenarkan ialah 35 MPa dan sudut putar yang dibenarkan ialah 2^0, kirakan tork maksimum yang dibenarkan.

(7 marks/markah)

(b). A three-point bend test is performed on a block of ceramic materials that is 20 cm long, 1.25 cm wide and 0.6 cm thick and is resting on 2 supports 9 cm apart. When a force of 1800 N is applied, the specimen deflects 0.012 cm and breaks. Compute the flexural strength and flexural modulus.

Ujian lenturan tiga titik dilakukan ke atas bongkah bahan seramik yang berukuran 20 cm panjang, 1.25 cm lebar dan 0.6 cm tebal terletak pada 2 sokongan berjarak 9 cm. Apabila daya 1800 N dikenakan, spesimen mengalami pesongan sebanyak 0.012 cm dan patah. Kira kekuatan lenturan dan modulus lenturan.

(5 marks/*markah)*

(3). (a). The state of plane stress shown occurs at a critical point of a steel machine component. As a result of several tensile tests, it has been found that the tensile yield strength is σ_y = 230 MPa for the grade of steel used. Compute the factor of safety with respect to yield using the maximum-shearing stress criterion. Explain the limitations of using this approach to calculate the factor of safety for materials.

Keadaan tegasan satah pada titik kritikal suatu komponen mesin diperbuat dari keluli dinyatakan seperti berikut. Keputusan beberapa ujian tegangan menunjukkan kekuatan alah bahan ini adalah σ_y = 230 MPa bagi gred keluli tersebut. Kirakan faktor keselamatan dengan merujuk kepada nilai alah menggunakan

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kriteria tegasan ricih maksimum.Terangkan kekurangan menggunakan pendekatan ini untuk menentukan faktor keselamatan sesuatu bahan.

$\sigma_x = 80$ MPa, $\sigma_y = -40$ MPa, $\tau_{xy} = 25$ MPa

(6 marks/*markah)*

(b). The state of plane stress at a point on the element is shown as follow. Construct the Mohr's circle and identify the state of stress when the element oriented 30° counter clock wise from the original position.

Keadaan tegasan satah pada suatu titik elemen dinyatakan seperti berikut. Lukis gambarajah bulatan Mohr dan kenalpasti keadaan tegasan apabila elemen mengalami orientasi 30° melawan jam daripada posisi asal.

$\sigma_x = -8$ MPa, $\sigma_y = 12$ MPa, $\tau_{xy} = -6$ MPa

(14 marks/*markah)*

PART B / *BAHAGIAN B*

(4). (a). The brass tube *AB*(*E* = 105 GPa) (Figure 1) has a cross-sectional area of 140 mm^2 and is fitted with a plug at *A*. The tube is attached at *B* to a rigid plate that is itself attached at *C* to the bottom of an aluminium cylinder (*E* = 72 GPa) with a cross-sectional area of 250 mm^2. The cylinder is then hung from a support at *D*. In order to close the cylinder, the plug must move down through 1 mm. Determine the force **P** that must be applied to the cylinder.

Tiub tembaga AB (E=105GPa) (Rajah 1) mempunyai keluasan keratan rentas 140mm^2 dan dipasangkan pada A dengan plug. Tiub tersebut juga dipasangkan pada B terhadap sesuatu plat tegar yang terpasang pada C di bahagian bawah silinder aluminum (E = 72 GPa) keluasan keratan rentasnya 250mm^2. Silinder tersebut kemudian digantung dari sokongan D. Untuk menutup silinder tersebut, plug mesti bergerak ke bawah sebanyak 1mm. Kirakan daya P yang mesti dikenakan kepada silinder.

(6 marks/*markah)*

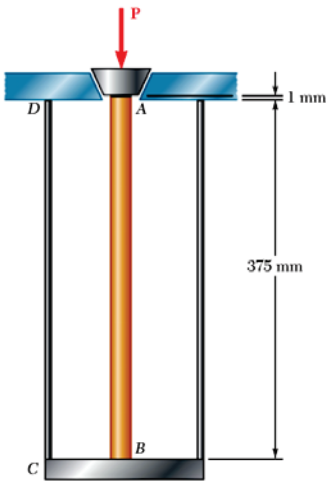

Figure 1/ *Rajah 1*

(b).# Figure 2 shows two cylindrical rods, steel and brass are joined at *C* and restrained by rigid supports at *A* and *E*. For the loading shown and knowing that E_s = 200 GPa and E_b = 105 GPa, determine (*a*) the reactions at A and *E*, (*b*) the deflection of point C.

Rajah 2 menunjukkan dua rod silinder keluli dan tembaga, disambung pada C dan dihadkan dengan sokongan tegar pada A dan E. Bagi beban ditunjukkan, dengan mengetahui E_s = 200 GPa dan E_b = 105 GPa, kirakan (a) tindakbalas di A dan E, (b) pesongan di C.

(14 marks/*markah)*

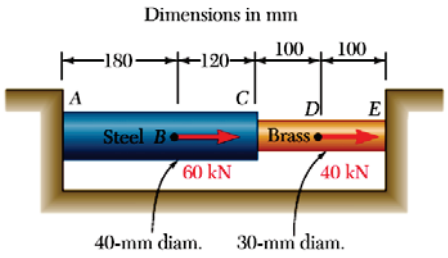

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Figure 2 / *Rajah 2*#

(5). (a). A steel shaft is to be manufactured as a solid circular bar. The shaft is required to transmit a torque of 1200 Nm without exceeding an allowable shear stress of 40 MPa or an allowable rate of twist of 0.750 ^{0}/m. The shear modulus of elasticity of the steel is 78 GPa. Determine the required diameter *d* of the solid shaft.

Aci keluli akan dibuat dalam bentuk bar bulat pepejal. Aci dikehendaki menghantar tork 1200 Nm tanpa melebihi tegasan ricih yang dibenarkan 40 MPa atau kadar putaran yang dibenarkan 0.750 ^{0}/m. *Modulus ricih keanjalan keluli ialah 78 GPa. Tentukan diameter d aci pepejal yang diperlukan*.

(10 marks/markah)

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(b). The flexural strength of a composite material reinforced glass fibers is 310 MPa, and the flexural modulus is 124.1 X 10^3 MPa. A sample which is 1.25 cm wide, 0.938 cm high, and 20 cm long, is supported between 2 rods 12.5 cm apart.

Kekuatan lenturan bagi gentian kaca bertetulang bahan komposit ialah 310 MPa, dan modulus lenturan ialah 124.1 X 103 MPa. Sampel yang berukuran 1.25 cm lebar, 0.938 cm tinggi dan 20 cm panjang, disokong antara 2 batang dengan jarak 12.5 cm.

(i) Determine the force required to fracture the material.
Tentukan daya yang diperlukan untuk mematahkan bahan.

(5 marks/markah)

(iii) Determine the deflection of the sample at fracture.
Tentukan pesongan sampel semasa patah.

(5 marks/markah)

(6). (a). The state of plane strain at a point has components of ε_x = -350(10^{-6}), ε_y = 200(10^{-6}), and γ_{xy} = 80(10^{-6}). Compute the principal strains at the point and the orientation of the element upon which they act.

Keadaan terikan satah pada suatu titik mempunyai komponen terikan, ε_x = -350(10^{-6}), ε_y = 200(10^{-6}), and γ_{xy} = 80(10^{-6}). Kirakan nilai terikan utama pada titik tersebut serta orientasi yang terlibat.

(8 marks/*markah)*

(b). At a point on the surface of a pressurized vessel, the material is subjected to biaxial stresses as shown on the stress element in Figure 3. Plot stress transformation (σ_x, τ_{xy}) versus angle (θ)

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between 0° to 360° in 45° increment. Prove that at maximum and minimum stresses values, there is no shear stress acting at that angle.

Pada titik permukaan bahan suatu kebuk tekanan dikenakan tegasan dwipaksi seperti ditunjukkan di dalam Rajah 3. Bagi setiap peningkatan sudut 45°, plot transformasi tegasan (σ_x, τ_{xy}) melawan sudut (θ) antara 0° to 360°. Buktikan pada nilai tegasan maksimum dan minimum, tiada tegasan ricih wujud pada sudut tersebut.

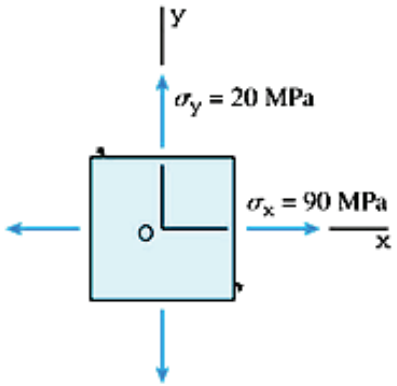

Figure 3: Stress element at point of on surface of pressurized vessel.

Rajah 3: Elemen tegasan pada titik permukaan kebuk tekanan

(12 marks/*markah)*

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