UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2010/2011

November 2010

EMM 101/3 – Engineering Mechanics
Mekanik Kejuruteraan

Duration : 3 hours
Masa : 3 jam

INSTRUCTIONS TO CANDIDATE:
ARAHAN KEPADA CALON:

Please check that this paper contains **TEN (10)** printed pages, **ONE (1)** page appendix and **FIVE (5)** questions before you begin the examination.
*Sila pastikan bahawa kertas soalan ini mengandungi **SEPULUH (10)** mukasurat bercetak, **SATU (1)** mukasurat lampiran dan **LIMA (5)** soalan sebelum anda memulakan peperiksaan.*

Answer **ALL** questions.
*Jawab **SEMUA** soalan.*

You may answer all questions in **English** OR **Bahasa Malaysia** OR a combination of both.
*Calon boleh menjawab semua soalan dalam **Bahasa Malaysia** ATAU **Bahasa Inggeris** ATAU kombinasi kedua-duanya.*

Answer to each question must begin from a new page.
Jawapan untuk setiap soalan mestilah dimulakan pada mukasurat yang baru.

In the event of any discrepancies, the English version shall be used.
Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.

Q1. **[a]** **Two forces F_1 and F_2 are applied to the hook, as shown in Figure Q1[a].**

(i) **Express each force in vector notation**

(ii) **Find the magnitude of the resultant of the two forces**

(iii) **Determine the direction cosines of the resultant force.**

Dua daya F_1 dan F_2 dikenakan pada cangkuk seperti dalam Rajah S1[a].

(i) *Nyatakan setiap daya dalam tatatanda vektor.*

(ii) *Dapatkan magnitud paduan kedua-dua daya.*

(iii) *Tentukan kosinus arah daya paduan.*

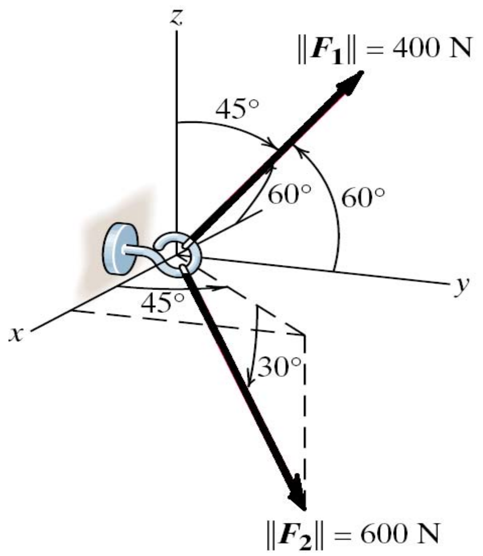

Figure Q1[a]
Rajah S1[a]

(40 marks/*markah*)

[b] **A T-shaped pipe is subjected by two couples as in Figure Q1[b]. Determine the magnitude of the resultant couple moments exerted on the pipe.**

Dua ganding dikenakan pada paip bentuk T seperti Rajah S1[b]. Tentukan magnitud momen ganding yang terjana pada paip.

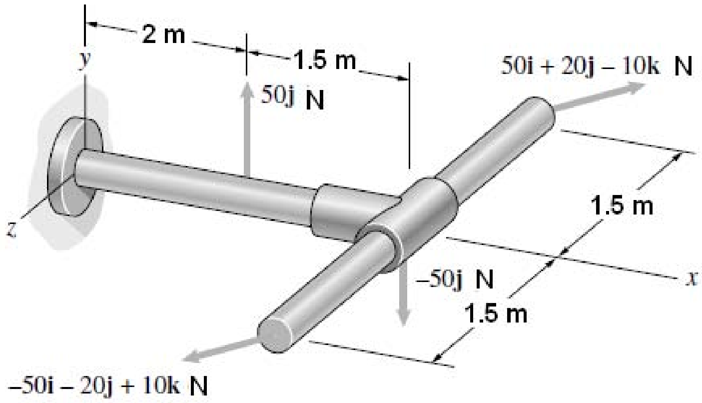

Figure Q1[b]
Rajah S1[b]

(30 marks/*markah*)

[c] **The plate shown in Figure Q1[c] is subjected to five parallel forces along the z-axes. Determine the x and y coordinates of a point through which the resultant of the parallel forces passes.**

Plat dalam Rajah S1[c] dikenakan lima daya selari dalam paksi z. Tentukan titik koordinat x dan y di mana paduan daya-daya selari melaluinya.

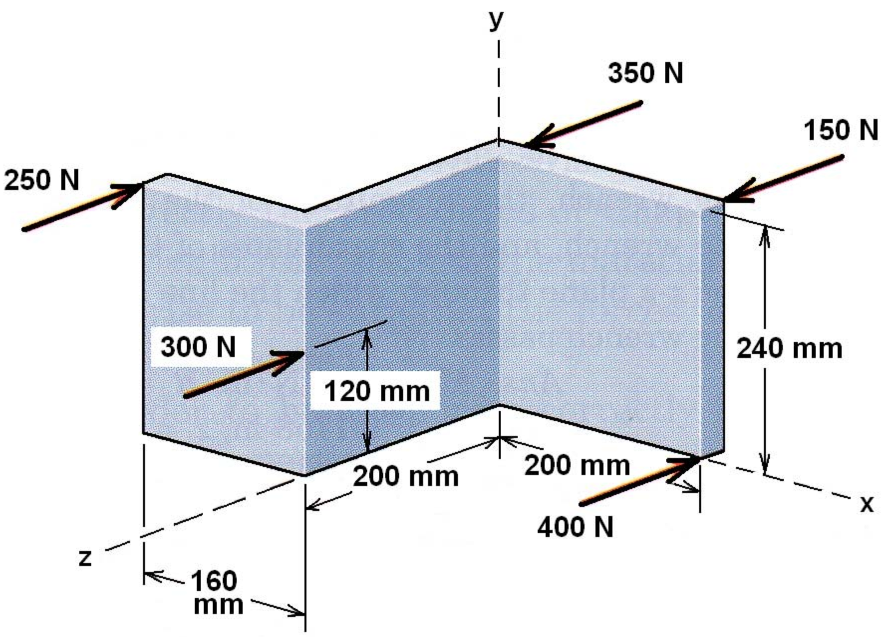

Figure Q1[c]
Rajah S1[c]

(30 marks/*markah*)

Q2. [a] **The system in Figure Q2[a] shows a collar slides on the smooth vertical bar. The collar A is tied to a rope which passes through a pulley B. The other end of the rope is attached with a balancer C and a spring. The masses, m_A = 20 kg and m_C = 10 kg and a spring constant k. When *h* = 0.1 m, the spring is un-stretched. Determine the spring constant k when the system is in equilibrium at h = 0.3 m.**

Sistem dalam Rajah S2[a] menunjukkan satu relang mengelongsor pada bar tegak yang licin. Relang A diikat tali yang melalui sebuah takal B. Salah satu hujung tali di gantung pengimbang C dan pegas. Jisim, m_A = 20 kg dan m_C = 10 kg juga kekakuan pegas k. Apabila h = 0.1 m, pegas tanpa terikan. Tentukan kekakuan pegas k apabila sistem dalam keseimbangan pada h = 0.3 m.

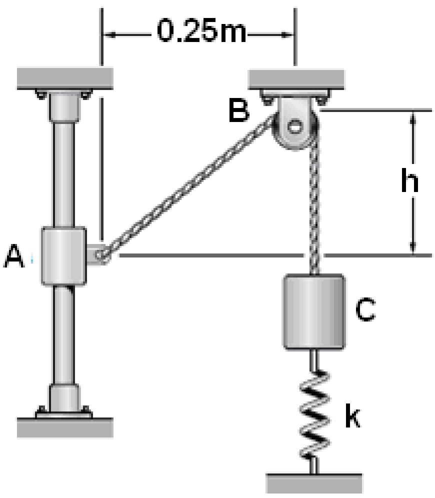

Figure Q2[a]
Rajah S2[a]

(50 marks/*markah***)**

[b] **Determine the coordinates of the centroid of the area given in Figure Q2[b] and also the second moment of area about the x axis.**

Tentukan koordinat sentroid untuk luas dalam Rajah S2[b] dan juga dapatkan momen luas kedua di sekitar paksi x.

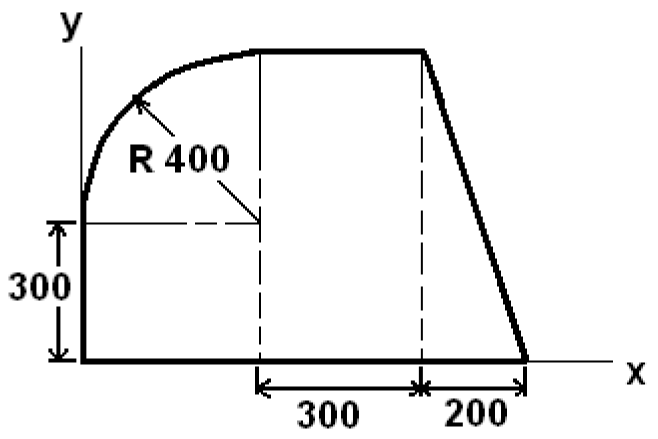

Figure Q2[b]
Rajah S2[b]

(50 marks/*markah*)

Q3. [a] State the general rule for support reactions.

Nyatakan hukum umum bagi tindakbalas penyokong.

(10 marks/*markah*)

[b] Draw the free body diagram for the following systems.

Lukis rajah badan bebas untuk sistem-sistem di bawah.

(i) A spanner wrench is subjected to 100 N force as in Figure Q3[b](i). The wrench is pin supported at A and the surface contact at B is smooth.

Perengkuh sepana ditindaki daya 100 N seperti Rajah S3[b](i). Perengkuh disokong pin di A dan pada sentuhan permukaan licin di B.

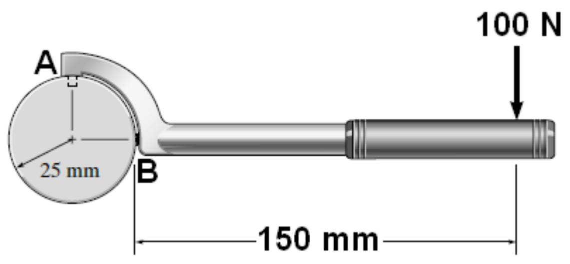

Figure Q3[b](i)
Rajah S3[b](i)

(10 marks/*markah*)

(ii) **The bent bar is fixed at A and loaded at end D. A spring is attached at B as shown in Figure Q3[b](ii).**

Bar bengkuk diikat di A dan dikenakan beban di D. Satu pegas dipasang di B seperti dalam Rajah S3[b](ii).

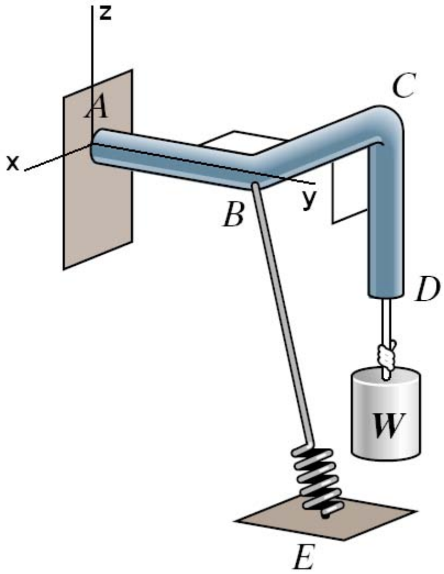

Figure Q3[b](ii)
Rajah S3[b](ii)

(10 marks/*markah*)

(iii) **An L-shaped bar is supported at A by a hinge and rests against a smooth surface and side wall at B. Two loads act as shown in Figure Q3[b](iii) and the weight of the bar is ignored.**

Satu bar bentuk L di sokong oleh engsel di A dan dalam keadaan sentuhan pada permukaan dan pada sisi yang licin di B. Dua beban bertindak seperti Rajah S3[b](iii) dan berat bar diabaikan.

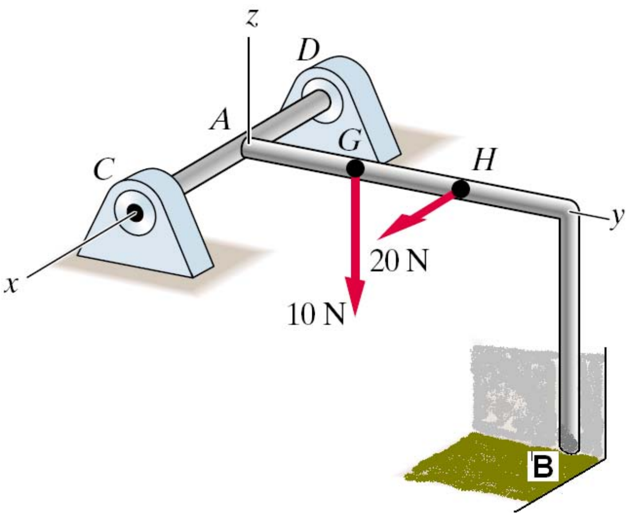

Figure Q3[b](iii)
Rajah S3[b](iii)

(10 marks/*markah*)

[c] **The light right-angle boom which supports 400 kg cylinder is supported by three cables AC, BD, BE and a ball-and-socket joint at O attached to the vertical x-y surface. (Figure Q3[c]). Determine the reactions at O and the cable tensions.**

Boom ringan sudut tepat yang menanggung silinder 400 kg disokong oleh tiga kabel AC, BD, BE dan sendi 'ball-and-socket' di O. Kabel dan sendi dipasang pada permukaan menegak x-y seperti (Rajah S3[c]). Tentukan tindakbalas di O dan ketegangan kabel.

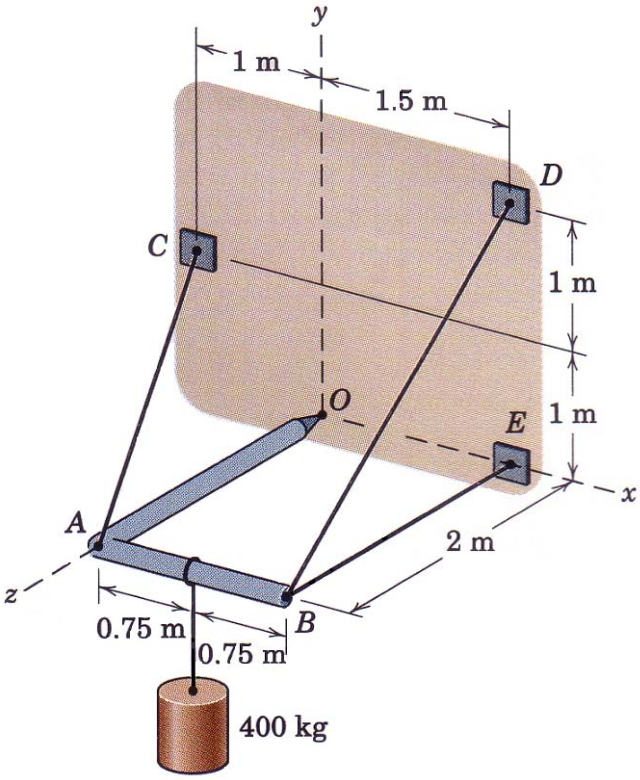

Figure Q3[c]
Rajah S3[c]

(60 marks/*markah***)**

Q4. [a] **As shown in Figure Q4[a], a motorcyclist at *A* is travelling at 18 m/s and he wishes to overtake the truck *T* which is travelling at a constant speed of 18 m/s. To do so, the motorcyclist accelerates at 1.8 m/s^2 until reaching a maximum speed of 25.5 m/s.**

Seperti yang ditunjukkan dalam Rajah S4[a], seorang penunggang motosikal di A bergerak pada kelajuan 18 m/s dan dia berhasrat untuk memotong sebuah trak T yang bergerak pada kelajuan malar 18 m/s. Untuk berbuat demikian, penunggang motosikal tersebut perlu memecut pada 1.8 m/s^2 sehingga mencapai kelajuan maksima 25.5 m/s.

(i) **If he then maintains this speed, determine the time needed for him to reach a point located 30 m in front of the truck.**

Jika dia meneruskan tunggangan pada kelajuan tersebut, tentukan masa yang diperlukan untuk dia berada pada kedudukan 30 m di hadapan trak tersebut.

(20 marks/*markah***)**

(ii) **Draw the *v-t* and *s-t* graphs for the motorcycle during this time.**

Lukis graf v-t dan s-t bagi motosikal tersebut sepanjang masa ini.

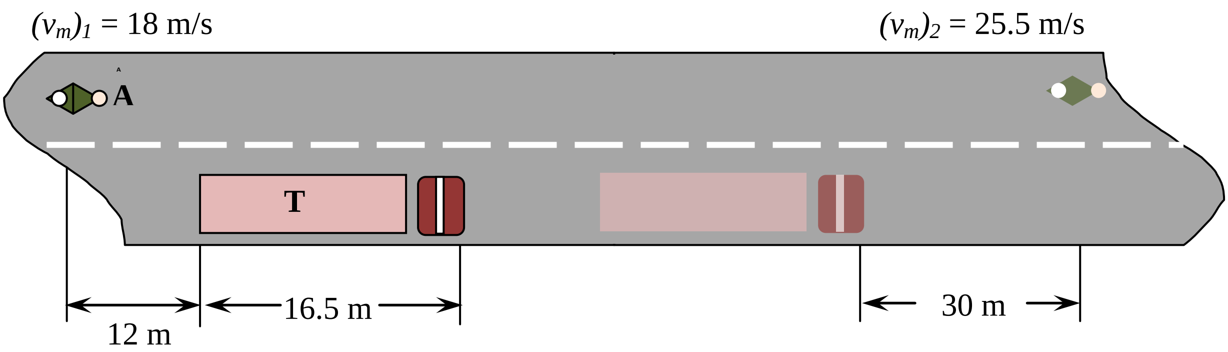

Figure Q4[a]
Rajah S4[a]

(15 marks/*markah***)**

[b] **A particle travels along the curve from *A* to *B* in 2 s. It takes 4 s for it to go from *B* to *C* and then 3 s to go from *C* to *D* as shown in Figure Q4[b]. Determine its average speed when it goes from *A* to *D*.**

Satu partikel bergerak sepanjang lengkungan dari A ke B dalam 2 s. Ia mengambil 4 s untuk bergerak dari B ke C dan kemudian 3 s untuk bergerak dari C ke D seperti yang ditunjukkan dalam Rajah S4[b]. Tentukan kelajuan puratanya apabila ia bergerak dari A ke D.

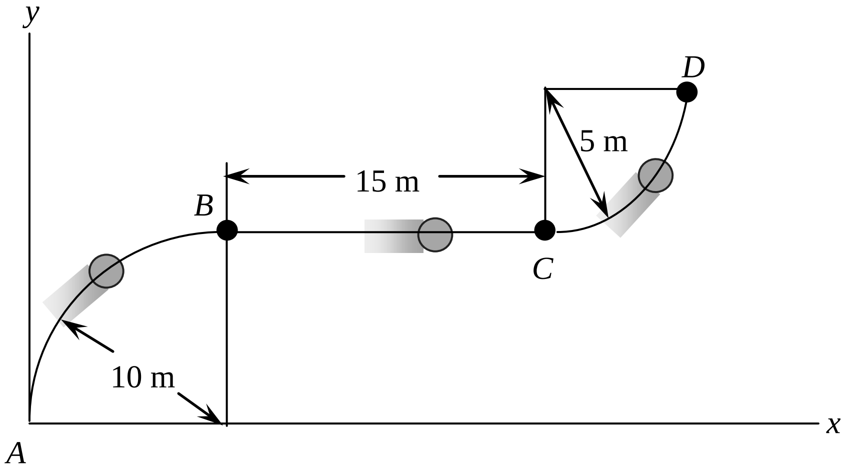

Figure Q4[b]
Rajah S4[b]

(15 marks/*markah***)**

[c] **Each of the three plates as shown in Figure Q4[c] has a mass of 10 kg. If the coefficients of static and kinetic friction at each surface of contact are μ_s = 0.3 and μ_k = 0.2, respectively, determine the acceleration of each plate when the three horizontal forces are applied.**

Bagi setiap ketiga-tiga kepingan yang ditunjukkan pada Rajah S4[c] mempunyai berat 10 kg. Jika pekali geseran statik dan kinetik pada setiap permukaan sentuhan adalah masing-masing μ_s = 0.3 dan μ_k = 0.2, tentukan pecutan bagi setiap kepingan apabila tiga daya mendatar dikenakan.

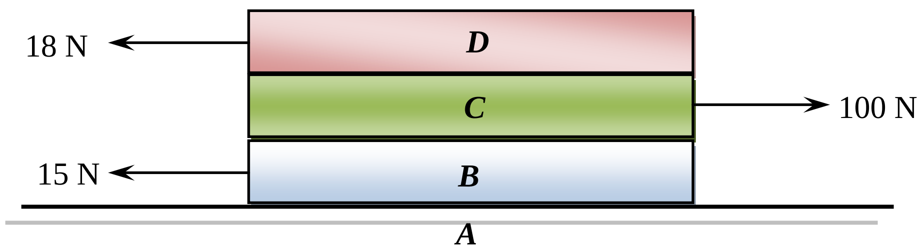

Figure Q4 [c]
Rajah S4 [c]

(50 marks/*markah***)**

Q5. **[a]** **If the spring is compressed 75 mm against the 0.5-kg block and it is released from rest as shown in Figure Q5[a], determine the normal force of the smooth surface on the block when it reaches distance, *s* = 150 mm.**

Jika satu spring ditekan 75 mm pada blok seberat 0.5 kg dan kemudian dilepaskan dari keadaan rehat seperti dalam Rajah S5[a], tentukan daya normal pada permukaan licin pada blok tersebut apabila ia menghampiri jarak s = 150 mm.

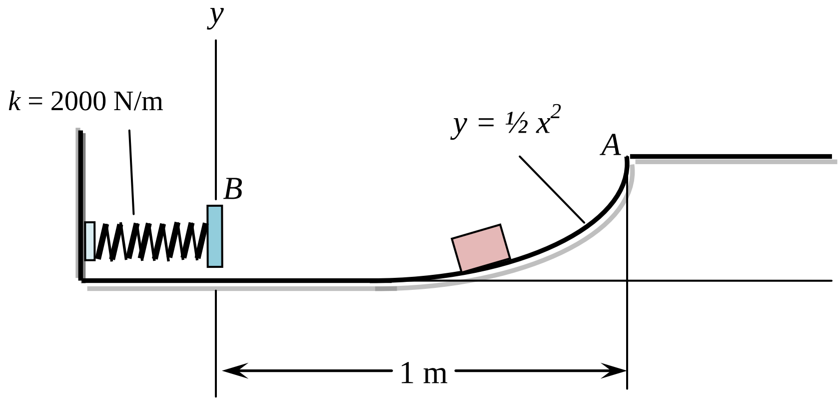

Figure Q5[a]

Rajah S5[a]

(60 marks/*markah*)

[b] **The 1-kg ball *A* is thrown so that when it strikes the 10-kg block *B* it is travelling horizontally at 10 m/s as in Figure Q5[b]. If the coefficient of restitution between A and B is *e* = 0.6, and the coefficient of kinetic friction between the plane and the block is μ_k = 0.4, determine the distance block *B* slides on the plane before stopping.**

Bola A yang seberat 1 kg dibaling supaya apabila ia melanggar 10 kg blok B, ia bergerak secara mendatar pada 10 m/s seperti dalam Rajah S5[b]. Jika pekali restitusi antara Adan B adalah e = 0.6, dan pekali geseran kinetik antara satah dan blok adalah μ_k = 0.4, tentukan jarak blok B meluncur pada satah tersebut sebelum ia berhenti.

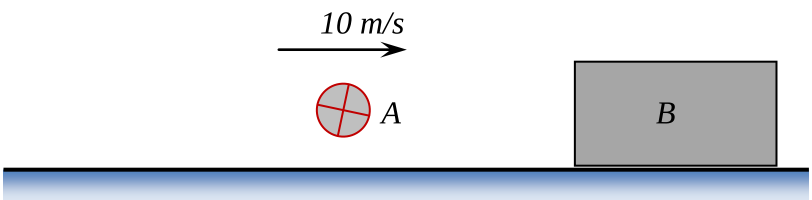

Figure Q5[b]

Rajah S5 [b]

(40 marks/*markah*)

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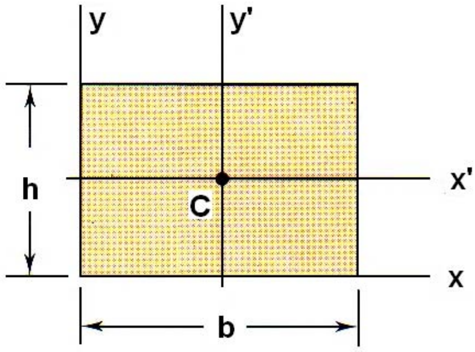
APPENDIX 1/*LAMPIRAN 1*

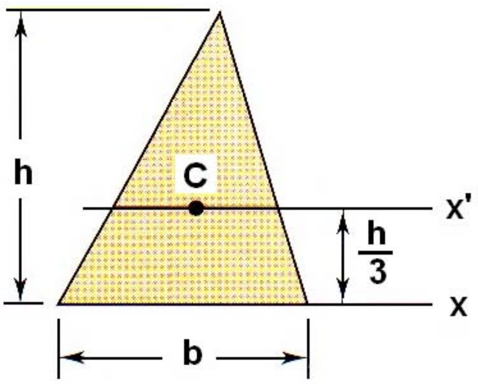
Centroid and Second Moment of Area of Common Shapes

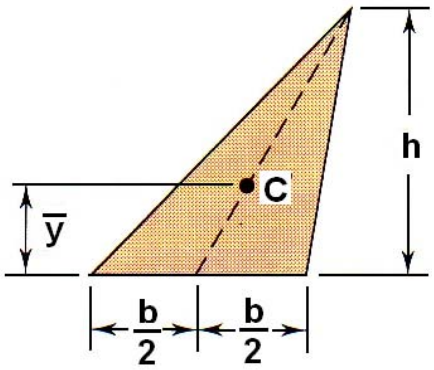


Rectangular

$$\bar{I}_{x'} = \frac{bh^3}{12}, \qquad I_x = \frac{bh^3}{3}$$

$$J_C = \frac{bh}{12}\left(b^2 + h^2\right)$$



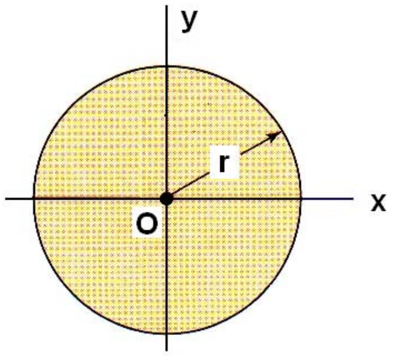


Triangular

$$\bar{I}_{x'} = \frac{bh^3}{36},$$

$$I_x = \frac{bh^3}{12}$$

$$\bar{y} = h/3$$



Circular

$$\bar{I}_x = \bar{I}_y = \frac{\pi r^4}{4}, \qquad J_o = \frac{\pi r^4}{2}$$

Semicircular

$$I_x = I_y = \frac{\pi r^4}{8}, \qquad J_o = \frac{\pi r^4}{4}$$

$$\bar{y} = \frac{4r}{3\pi}$$

Quarter-circular

$$I_x = I_y = \frac{\pi r^4}{16}, \qquad J_o = \frac{\pi r^4}{8}, \qquad \bar{x} = \bar{y} = \frac{4r}{3\pi}$$