UNIVERSITI SAINS MALAYSIA

2nd. Semester Examination
2004/2005 Academic Session
Peperiksaan Semester Kedua
Sidang Akademik 2004/2005

March 2005

EAS 254E/3 – Structural Analysis
EAS 254E/3 – Analisis Struktur

Duration: 3 hours
Masa : 3 jam

Instructions to candidates:
Arahan kepada calon:

1. Ensure that this paper contains **TWELVE (12)** printed pages.
   Sila pastikan kertas peperiksaan ini mengandungi DUA BELAS (12) muka surat bercetak sebelum anda memulakan peperiksaan ini.

2. This paper contains **FIVE (5)** questions. Answer all **FIVE (5)** questions.
   *Kertas ini mengandungi **LIMA (5)** soalan. Jawab kesemua **LIMA (5)** soalan.*

3. All questions **CAN BE** answered in English or Bahasa Malaysia or combination of both languages.
   Semua soalan boleh dijawab dalam Bahasa Inggeris atau Bahasa Malaysia ataupun kombinasi kedua-dua bahasa.

4. All question **MUST BE** answered on a new sheet.
   Semua jawapan MESTILAH dijawab pada muka surat yang baru.

5. Write the answered question numbers on the cover sheet of the answer script.
   Tuliskan nombor soalan yang dijawab di luar kulit buku jawapan anda.

1. (a) Statically indeterminate structures are those structures with redundancies. Explain the meaning of redundancy and its advantage by using a suitable example.

(a) Struktur tidak bolehtentu statik adalah struktur dengan lelebihan (redundancy). Terangkan maksud lelebihan dan faedahnya dengan menggunakan satu contoh yang sesuai.

(6 marks)

(b) Figure 1.0 shows a seven-member truss for a roof structure subjected to a load of 40 kN at joint A. Support F is a pin and support C is of roller type. Length and cross sectional area of members of the truss together with the member forces are shown in Table 1.0. An additional member E-C with the same cross-sectional area has been considered to be added to the truss structure.

(b) Rajah 1.0 menunjukkan satu kekuda dengan tujuh anggota yang digunakan untuk satu struktur bumbung. Struktur kekuda berkenaan dikenakan satu beban 40kN pada sambungan A. Penyokong F adalah jenis pin manakala penyokong C adalah jenis rola. Panjang anggota, luas keratan anggota dan daya paksi dalam anggota diberi dalam Jadual 1.0. Satu anggota tambahan E-C dengan luas keratan yang sama seperti anggota lain telah dipertimbangkan untuk ditambah kepada struktur kekuda berkenaan.

i. Determine the axial force in the additional member E-C by using method of consistent deformation. Assume E to be the same for all members.

i. Tentukan daya paksi dalam anggota tambahan E-C dengan menggunakan kaedah ubahbentuk konsisten. Anggap E adalah sama untuk semua anggota.

ii. If the cross-sectional area of additional member E-C used is twice as big as the cross-sectional areas of the rest of the members, comment on the effect of this increase in cross-sectional area on the magnitude of axial force in member E-C. Make use of your calculation in part (i).

ii. Sekiranya luas keratan anggota tambahan E-C adalah dua kali lebih besar daripada luas keratan anggota lain, beri komen tentang kesan pertambahan luas keratan ini ke atas magnitud daya paksi dalam anggota tambahan E-C. Gunakan maklumat pengiraan anda dalam bahagian (i).

(14 marks)

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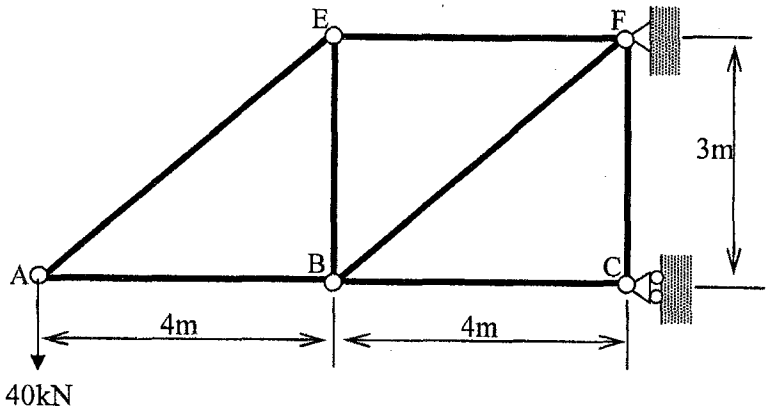

Figure 1.0

Table 1.0

Member	L (m)	A(mm^2)	Member force(kN)
EF	4	100	53.33
AB	4	100	-53.33
BC	4	100	-106.67
AE	5	100	66.67
BE	3	100	-40.00
BF	5	100	66.67
CF	3	100	0.00

(compression : negative ; tension : positive)

...4/-

2. (a) Figure 2.0 (a) shows a propped cantilevered column subjected to a uniformly distributed load w. Supports A and B are of fixed and roller types, respectively. Derive the expression for reaction at support B by using method of least work.

(a) Rajah 2.0 (a) menunjukkan satu tiang julur yang ditopang pada hujung bebas. Tiang berkenaan dikenakan satu beban teragih seragam w. Penyokong A adalah jenis tegar manakala penyokong B adalah jenis rola. Terbitkan persamaan untuk daya tindakbalas pada B dengan menggunakan kaedah kerja terkurang.

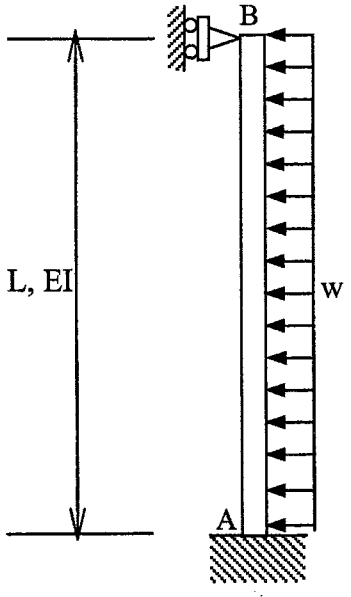

Figure 2.0 (a)

(6 marks)

(b) Figure 2.0 (b) shows the design proposal for L-frame ABC. In this design proposal, support A is fixed and support C is of pin type. The load carried by the L-frame is a uniformly distributed load of 15kN/m acting on member BC and a point load of 30kN acting at joint B. Moment inertia of sections used for member AB and BC are I and 1.5I, respectively. The reaction forces for this frame have been calculated and the values are as shown in Table 2.0. Immediately after construction, it has been found out that horizontal restraint of support C does not function. As a structural engineer, you have been asked to carry out analysis to investigate the effect of such change in support condition on the reaction forces. Calculate the percentage change in the magnitude of support reactions at A as a results of the failure of support C to provide horizontal restraint.

Use method of least work in your analysis. Assume E to be the same for both members AB and BC.

(b) Rajah 2.0 (b) menunjukkan cadangan rekabentuk untuk satu kerangka ABC yang berbentuk L. Dalam cadangan rekabentuk ini, penyokong A adalah jenis tegar manakala penyokong C adalah jenis pin. Kerangka berkenaan dikenakan beban teragih seragam 15kN/m di sepanjang anggota BC dan satu beban tertumpu 30kN pada sambungan B. Momen sifatekun keratan untuk anggota AB adalah I manakala untuk anggota BC adalah 1.5I. Daya tindakbalas untuk kerangka yang ditunjukkan dalam Rajah 2.0 (a) telah dikira dan nilai-nilai berkenaan ditunjukkan dalam Jadual 2.0. Selepas pembinaan siap dijalankan, didapati bahawa kekangan u fuk pada penyokong C tidak berfungsi. Sebagai seorang jurutera struktur, anda telah diminta untuk menjalankan penyiasatan ke atas kesan perubahan keadaan penyokong pada C ke atas nilai-nilai daya tindakbalas. Kira peratus perubahan dalam nilai-nilai daya tindakbalas pada penyokong A akibat kegagalan kekangan ufuk pada penyokong C.

Guna kaedah kerja terkurang dalam analisis anda. Anggap E adalah sama untuk kedua-dua anggota AB dan BC.

(14 marks)

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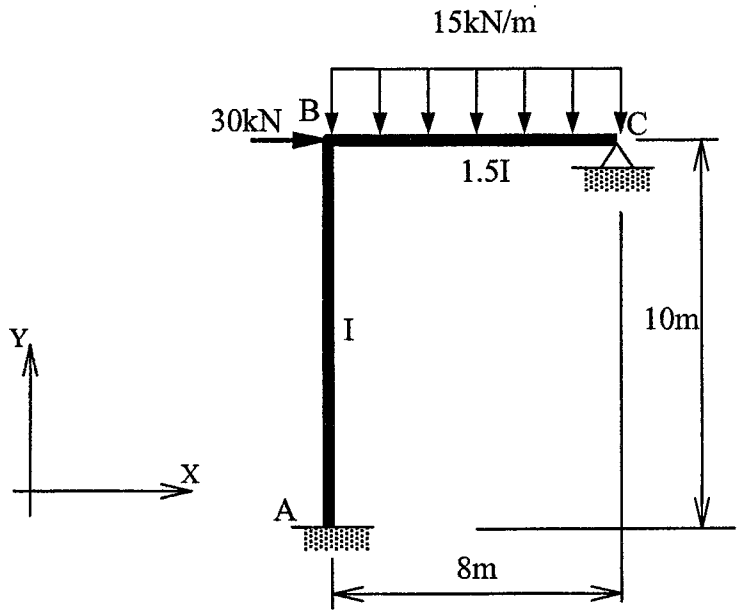

Figure 2.0 (b) An L-frame

Table 2.0 Reaction forces for L-frame in Figure 2.0 (b)

Support A	Horizontal reaction force,	A_X = 7.481kN (→)
	Vertical reaction force,	A_Y = 66.234kN (↑)
	Moment reaction,	M_A= 24.935kNm (↷)
Support C	Horizontal reaction force,	C_X= 37.481kN (←)
	Vertical reaction force,	C_Y= 53.766kN (↑)

3. (a) During construction of a bridge across a river as shown in Figure 3.0, the load on each beam is assumed to be ***w*** kN/m, which includes the weight of the beam. The beams are simply supported at piers with a span length of ***L*** meter. The beam is also subjected to a concentrated load of ***P*** kN at mid span and a clockwise moment of M_0 kN.m at left-hand support (point A) of the beam. Determine the vertical deflection at mid span of the beam in terms of *w*, *P*, M_0 and *L* using the energy method.

(a) Semasa pembinaan sebuah jambatan merentasi sungai seperti yang ditunjukkan dalam Rajah 2.0, beban yang dikenakan ke atas setiap rasuk dianggarkan sebanyak w kN/m dan ini termasuk berat rasuk tersebut. Rasuk jambatan disokong mudah antara tiang sambut dengan jarak L meter. Beban tumpu sebanyak P kN bertindak ke atas rasuk di pertengahan rentang rasuk dan momen ikut arah jam sebanyak M_0 kN.m bertindak pada penyokong kiri rasuk (titik A). Tentukan pesongan pugak di pertengahan rentang rasuk dalam sebutan w, P, M_0 dan L dengan menggunakan kaedah tenaga.

(12 marks)

(b) The allowable deflection of the beam is 1/360 of the span length. Check the deflection at mid span of the beam if *w* = 20 kN/m, P = 30 kN, M_0 = 5 kN.m and *L* = 12 m. Take E = 200 GPa and I = 600(10^6) mm^4. Comment the answer.

(b)Pesongan yang dibenarkan untuk rasuk ialah 1/360 daripada panjang rentang rasuk. Semak pesongan di pertengahan rentang rasuk jika w = 20 kN/m, P = 30 kN, M_0 = 5 kN.m dan L = 12 m. Guna E = 200 GPa dan I = 600(10^6) mm^4. Komen jawapan yang diperolehi.

(5 marks)

(c) If the deflection at mid span of the beam exceeds 1/360 of the span length, what are the measures that can be taken in order to ensure the deflection of the beam does not exceed the limit. Briefly state any three possible measures.

(c) Jika pesongan di pertengahan rentang melebihi 1/360 panjang rentang, apakah tindakan yang perlu diambil supaya pesongan rasuk berkenaan tidak melebihi had tersebut. Nyatakan dengan ringkas tiga langkah yang boleh diambil.

(3 marks)

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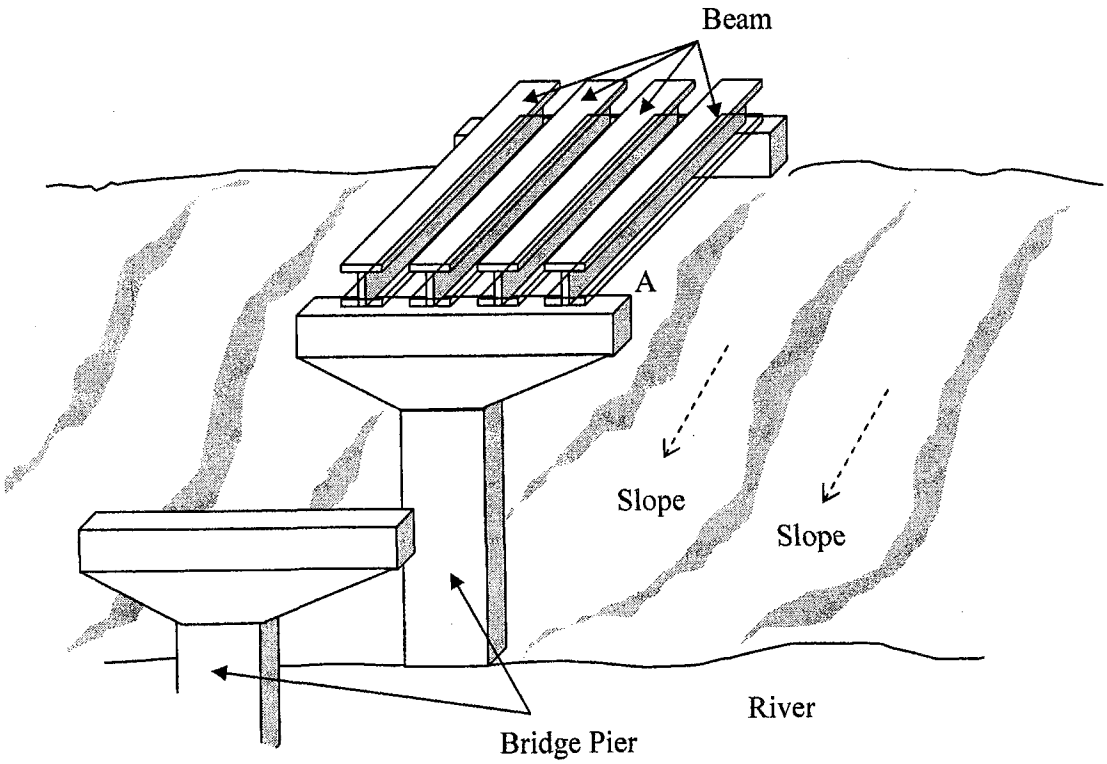

Figure 3.0

4. (a) Figure 4.0 (a) shows a frame carrying a uniformly distributed load of 50 kN/m on span BC. Support A and D are fixed. EI value for all member is constant, value of E = 200 GPa and value of I = 400 x 10^6 mm^4. Using the Slope Deflection Method, calculate the rotation θ_B and θ_C and the moment at all joints for the frame. Hence sketch the deflected shape and bending moment diagram of the frame. Neglect axial deformation

(a) Rajah 4.0 (a) menunjukkan satu kerangka yang membawa beban teragih seragam 50kN/m bertindak di sepanjang rentang BC. Penyokong A dan D adalah jenis tegar. Nilai EI adalah konstan untuk semua anggota dan nilai E = 200 GPa dan I = 400 x 10^6 mm^4. Dengan menggunakan Kaedah Cerun Pesongan, kira nilai putaran θ_B dan θ_C dan momen di setiap sambungan kerangka. Seterusnya lakarkan bentuk terpesong kerangka tersebut dan rajah momen lentur. Abaikan pesongan paksi.

(15 marks)

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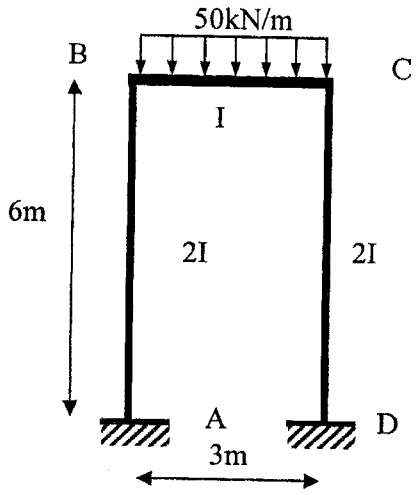
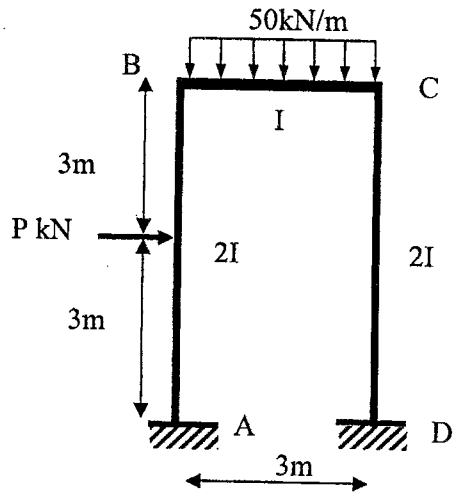
(b) If an additional horizontal force P (kN) is applied at the mid-height of the column AB as shown in Figure 4.0 (b), sketch the new deflected shape and bending moment diagram without additional calculation.

(b) Sekiranya satu daya tumpu mengufuk, P (kN) dikenakan di tengah rentang AB seperti yang ditunjukkan dalam Rajah 4.0 (b), lakarkan gambarajah pesongan dan rajah momen lentur yang baru tanpa sebarang pengiraan.

(5 marks)



Rajah 4.0 (a)



Rajah 4.0 (b)

5. Figure 5.0 shows a continuous beam carrying a uniformly distributed load of 20 kN/m on span AB and CD and a point load of 100 kN on span BC. Assuming that EI is constant and by using the Moment Distribution Method:

(a) Calculate the bending moment
(b) Sketch the bending moment diagram
(c) Sketch the shear force diagram
(d) Sketch the deflected shape of the loaded beam

Rajah 5.0 menunjukkan satu rasuk selanjar yang membawa beban teragih seragam sebanyak 20 kN/m direntang AB dan CD dan beban tumpu 100 kN direntang BC. Anggap nilai EI adalah malar. Dengan menggunakan Kaedah Agihan Momen:

(a) Kira nilai momen lentur
(b) Lakar gambarajah momen lentur
(c) Lakar gambarajah daya ricih
(d) Lakar bentuk pesongan rasuk selanjar tersebut

(20 marks)

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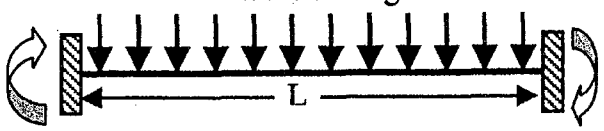
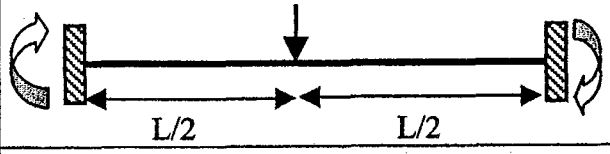
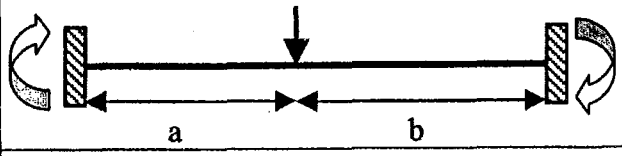
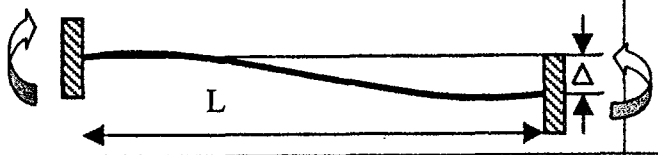
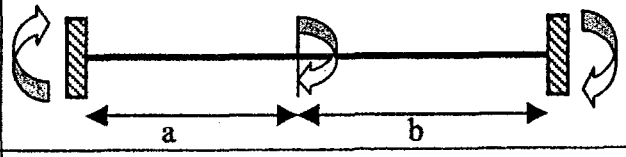
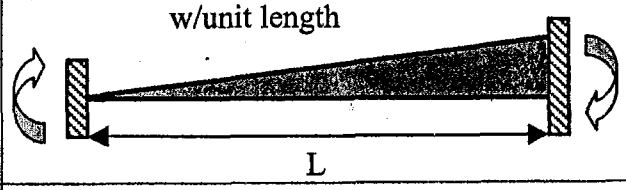
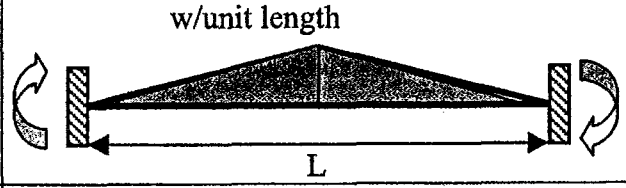
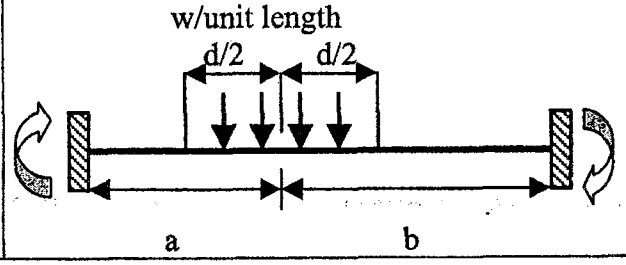
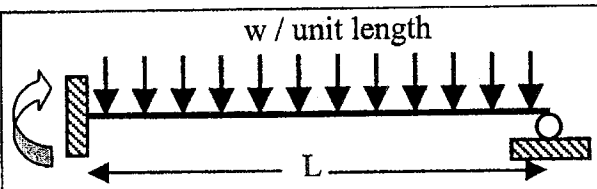
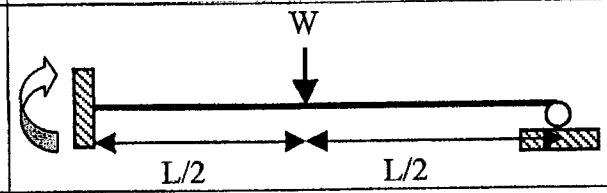
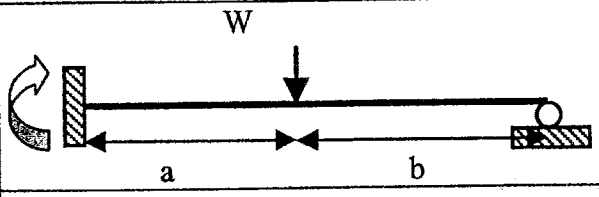
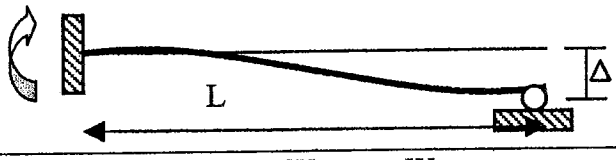
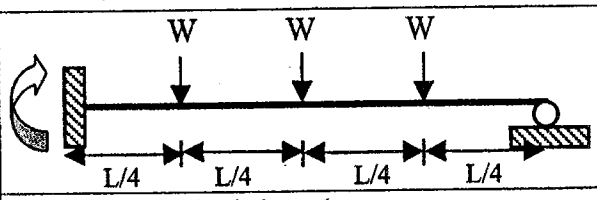
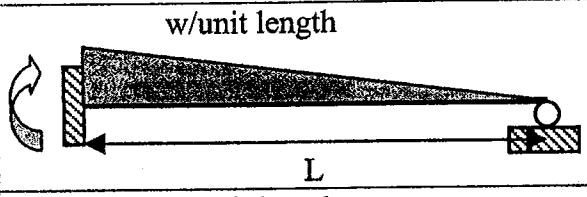
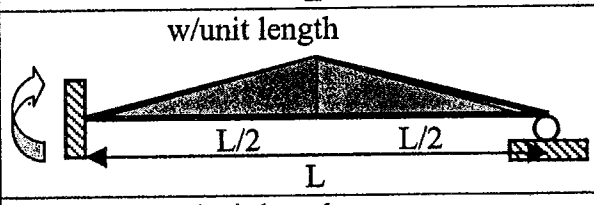
Attachment :

Fixed End Moment

$-\frac{wL^2}{12}$	w / unit length  	$\frac{wL^2}{12}$
$-\frac{WL}{8}$	W  	$\frac{WL}{8}$
$-\frac{Wab^2}{L^2}$	W  	$\frac{Wba^2}{L^2}$
$-\frac{6EI\Delta}{L^2}$	 	$\frac{6EI\Delta}{L^2}$
$-\frac{Mb(2a-b)}{L^2}$	M  	$\frac{Mb(2b-a)}{L^2}$
$-\frac{wL^2}{30}$	w/unit length  	$\frac{wL^2}{20}$
$-\frac{5wL^2}{96}$	w/unit length  	$\frac{5wL^2}{96}$
$-\frac{wd}{L^2}\left(ab^2+\frac{(a-2b)d^2}{12}\right)$	w/unit length  	$\frac{wd}{L^2}\left(a^2b+\frac{(b-2a)d^2}{12}\right)$

Attachment :

Fixed End Moment

$-\frac{wL^2}{8}$		
$-\frac{3WL}{16}$		
$-\frac{W}{L^2}\left(b^2a+\frac{a^2b}{12}\right)$		
$-\frac{3EI\Delta}{L^2}$		
$-\frac{45WL}{96}$		
$-\frac{wL^2}{15}$		
$-\frac{5wL^2}{64}$		
$-\frac{9WL^2}{128}$