Ministry of Higher Education
Giza Higher Institute for Eng. & Tech.
Civil Engineering Department
Course Name: **Theory of Structures (4)**
Course Code : **CIV 302**

Academic Year : **2013–2014**
Semester : **Second**
Level : **3rd**
Time : **--- Hours**
Date : **5 / 5 / 2014**
Examiner: ***Dr. M. Abdel-Kader***

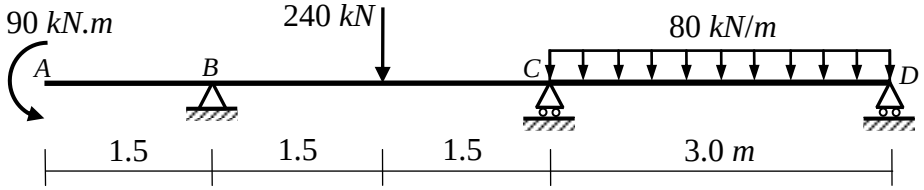
الاسم: **رقم الكود:**

امتحـــــان منتصف الترم

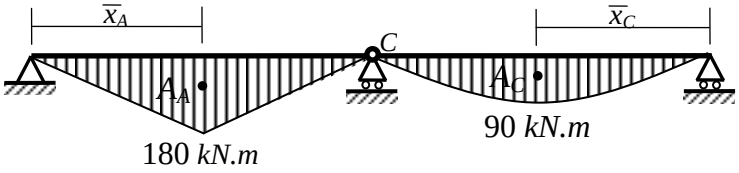
- The Exam consists of **2** questions in **2** pages.

Question (1): (10 Marks)

Using the three-moments equation, draw the shear force and bending moment diagrams for the shown beam



Solution of Question (1)



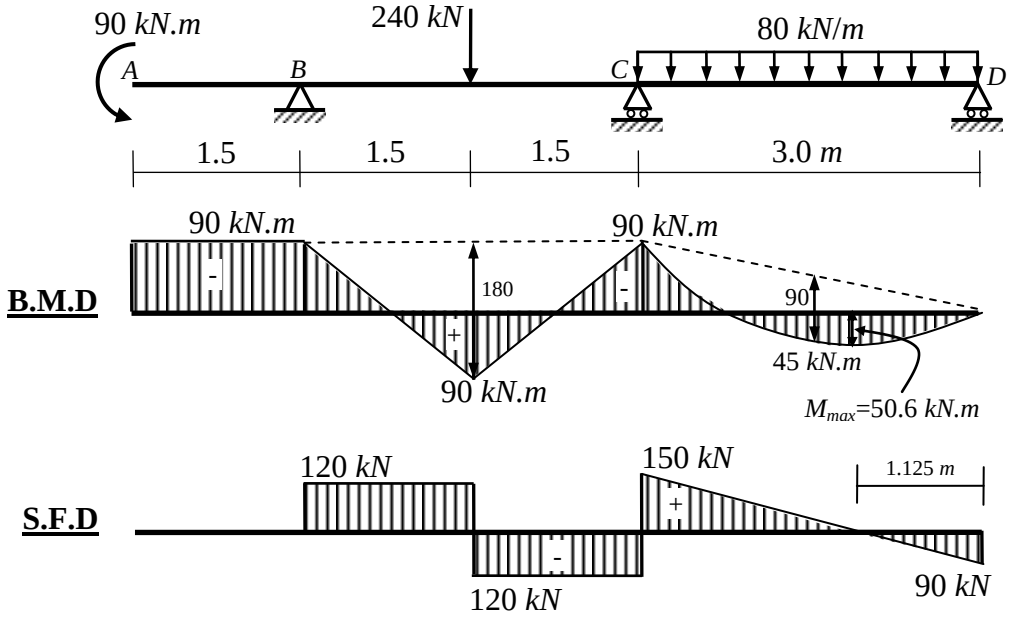
Applying three-moments equation for the spans BC and CD:

$$M_B(3) + 2M_C(3+3) + M_D(3) = -6\left(\frac{(0.5\times 3\times 180)1.5}{3} + \frac{(2/3\times 3\times 90)1.5}{3}\right)$$

$(-90)(3) + 2M_C\,(6) + (0)(3) = -1350$

$12M_C = -1080 \quad \rightarrow \quad \boxed{M_C = -90\ kN.m}$

The bending moment and shear force diagrams are shown below.

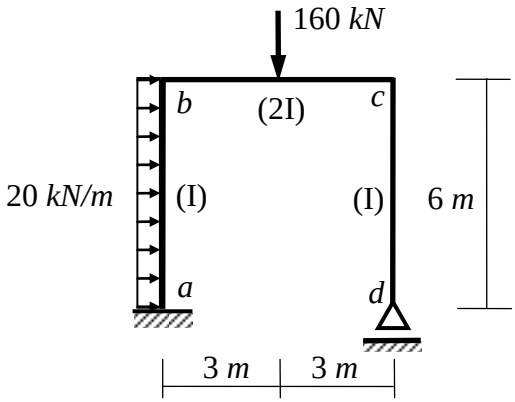


Please turn over

Question (2): (10 Marks)

For the shown frame with variable moment of inertia, using the **Consistent Deformations** (**Virtual Work**) method, draw the bending moment diagram due to the given loads.

E is constant. The relative moments of inertia are given between brackets.



Solution of Question (2)

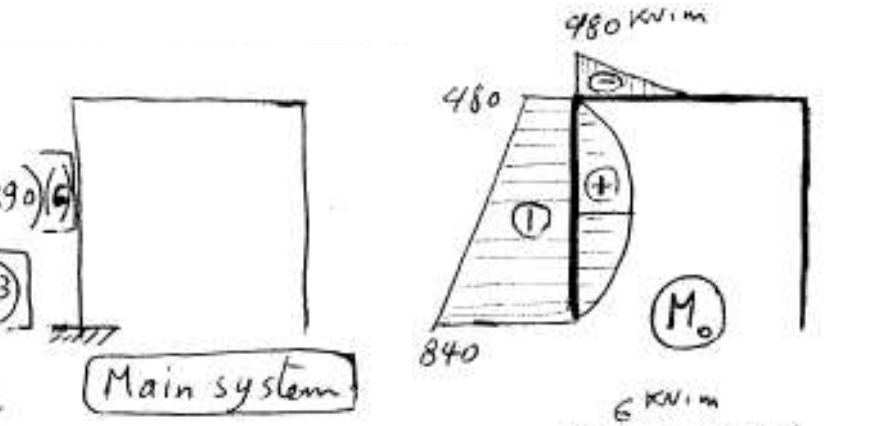
$$\delta_{10} = \int \frac{M_0 M_1}{EI} dl$$

$$= \frac{1}{EI}\left[-\left(\frac{480+840}{2}\times 6\right)(6) + \left(\frac{2}{3}\times 6\times 90\right)(6)\right]$$

$$+ \frac{1}{2EI}\left[-\left(\frac{1}{2}\times 3\times 480\right)\left(3+\frac{2}{3}\times 3\right)\right]$$

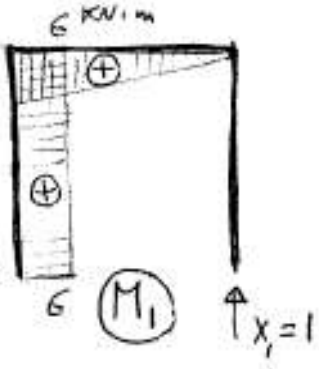
$$= \frac{-2376+2160}{EI} + \frac{-3600}{2EI}$$

$$= \boxed{-\frac{23400}{EI}}$$

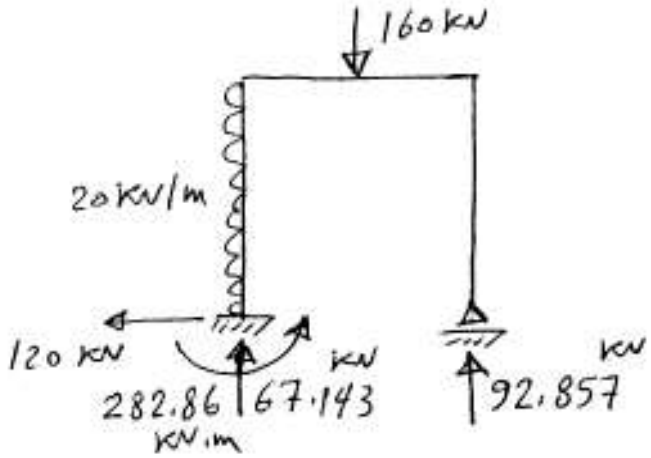


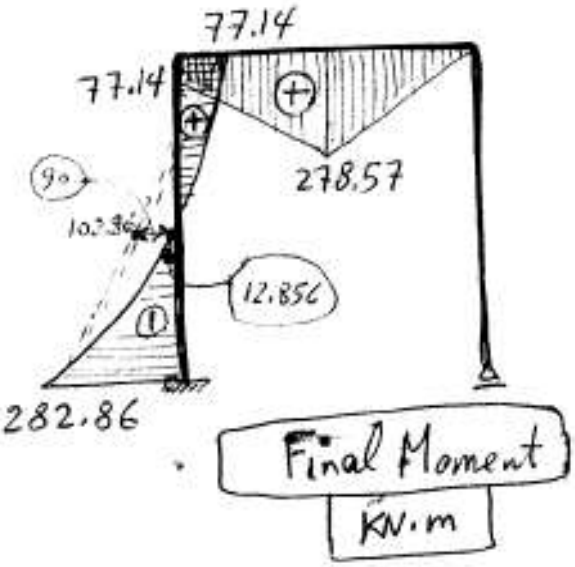
$$\delta_{11} = \int \frac{M_1 M_1}{EI} dl = \frac{1}{EI}\left[(6\times 6)(6)\right] + \frac{1}{2EI}\left[\left(\frac{1}{2}\times 6\times 6\right)\left(\frac{2}{3}\times 6\right)\right]$$

$$= \frac{216}{EI} + \frac{72}{2EI} = \boxed{\frac{252}{EI}}$$



$$\delta_{10} + X_1 \delta_{11} = 0 \Longrightarrow X_1 = -\frac{\delta_{10}}{\delta_{11}} = -\frac{-23400}{252} = \boxed{92.857}\ \text{KN}$$





With my best wishes

Dr. M. Abdel-Kader