B. Sc. Engg. (CEE)/ 5th Sem. 11 October, 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Mid-Semester Examination **Winter Semester: 2022 - 2023**
Course No.: CEE 4511 **Full Marks: 75**
Course Title: Design of Concrete Structures I **Time: 1.5 Hours**

There are **3 (THREE)** questions. Answer all questions. The symbols have their usual meaning.

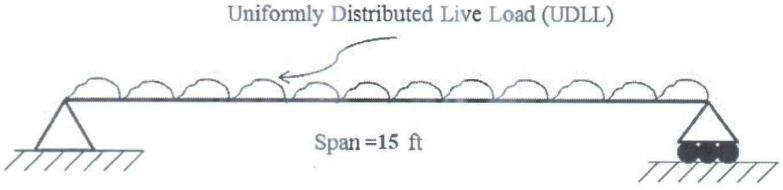
1(a) Draw the qualitative stress diagram and strain diagram across the section of a beam under pure flexure for the conditions below: **CO1 PO1** **5**

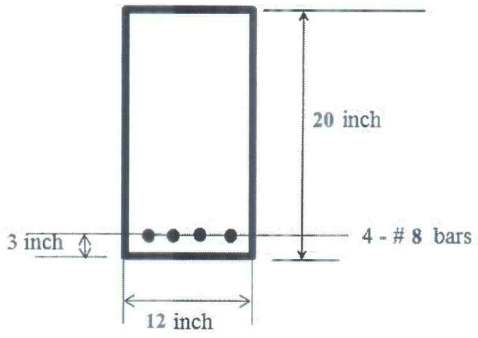
i. Considerably low bending moment, elastic stress-strain behavior, tensile stress in concrete is less than its modulus of rupture;
ii. Relatively higher bending moment, elastic stress-strain behavior, tensile stress in concrete is higher than its modulus of rupture;
iii. High bending moment, inelastic stress-strain behavior, tensile stress in concrete is considerably higher than its modulus of rupture.

(b) Explain briefly three factors that prevent the compression steel bars in a doubly reinforced concrete beam from reaching yield strain at failure. **CO1 PO1** **5**

(c) When is it necessary to analyze or design a beam as a doubly reinforced beam? **CO1 PO1** **5**

2 Refer to the simply supported RC beam shown below: **CO2 PO2** **30**





Beam Section

Given: $f_c' = 3500$ psi, $f_y = 60{,}000$ psi, $f_s = 20{,}000$ psi, unit weight of concrete = 150 lb/ft^3, $f_{tr} = 7.5\sqrt{f_c'}$

Calculate the following:

(i) Cracking moment,

(ii) Minimum amount of UDLL to produce crack in beam (hint: consider the self-weight of the beam as dead load),

(iii) For a moment of 40 k-ft, draw stress and strain distribution across the section,

(iv) Calculate the working moment capacity for the beam,

(v) Draw stress diagram for the beam section at maximum working moment showing the values of maximum stresses in concrete and steel,

(vi) Calculate the nominal moment capacity for the beam,

(vii) Draw stress diagram for the beam section at nominal moment showing the values of compressive force on concrete and tensile force on steel.

3(a) Design the following simply-supported RC beam for flexure by **WSD** and **USD** methods. **CO3 PO3** **30**

Given: UDLL = 0.5 *k/ft*, UDDL (dead load) = 1.5 *k/ft* (**including self-weight**). Assume, $f_c' = 4$ ksi, $f_s = 20$ ksi, $f_y = 60$ ksi, width of beam = 14 in.

(b) Compare the sections and steel areas obtained by using WSD and USD methods on the basis of cost and sustainability (in terms of materials consumption).

(c) If you change the supports at both ends to "fixed supports" instead of "hinge/pin supports", what changes in design will occur? Briefly explain using texts and figures *without any calculations*.