First Semester Examination
2020/2021 Academic Session

February 2021

EAS457 – Structural Steel Design

Duration : 1 hours

Please check that this examination paper consists of **FOUR (4)** pages of printed material before you begin the examination.

Instructions : This paper contains **TWO (2)** questions. Answer **ALL** questions.

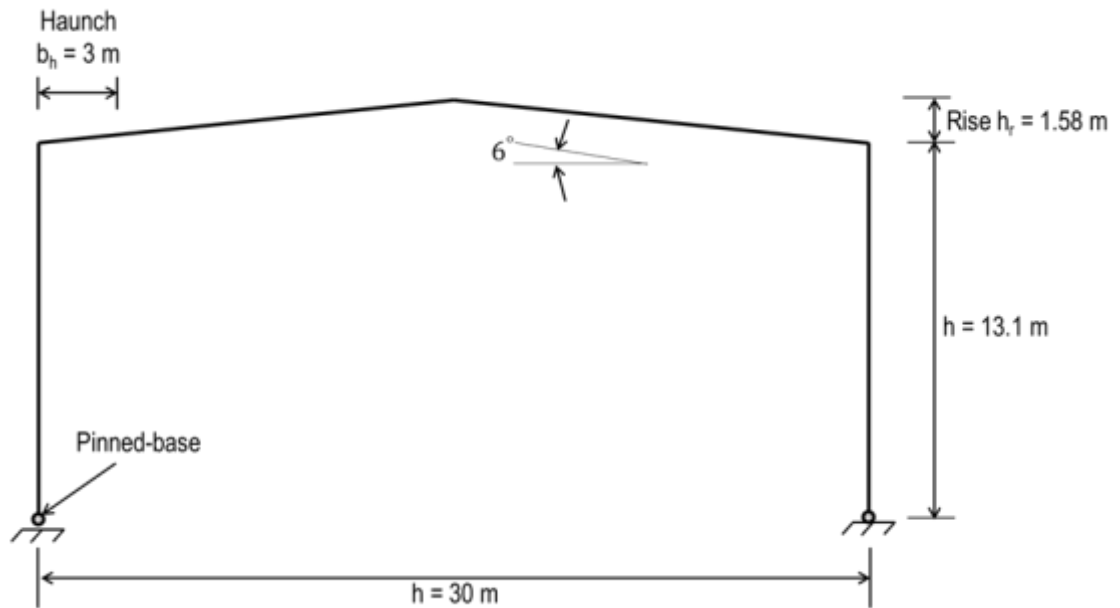All questions **MUST BE** answered on a new page.

1. (a). A member of the web chord is subjected to a compression load of 1500 kN. As an engineer, you are required to check the suitability of a $244.5 \times 8\ \text{CHS}$ section in resisting the load. Assume the member is classified under Class 1 section and the steel is $\text{Fe}\ 430\ (S275)$.
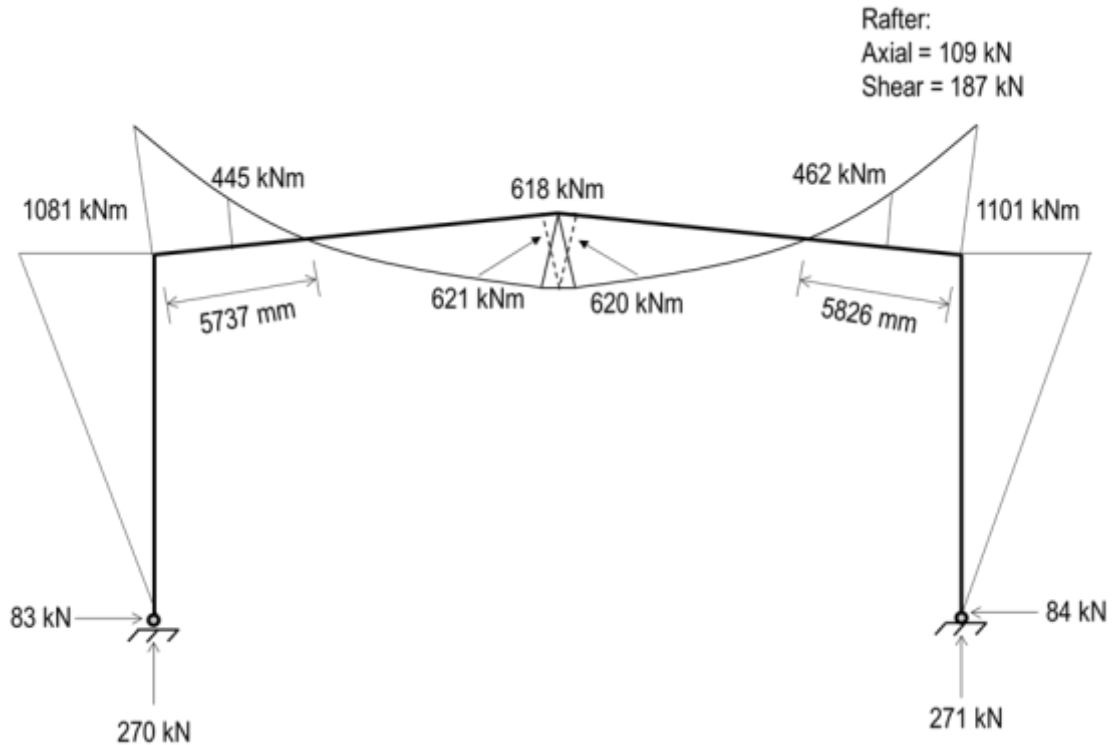
[24 marks]

(b). A tension member consists of a 150 × 90 × 10 single unequal angle whose ends are connected to gusset plates through the larger leg by a single row of four 22 mm bolts in 24 mm holes at 60 mm centres. Check the tension member for a design tension force of $N_{t,Ed} = 300\ \text{kN}$. Assume the steel grade is S275 and a member is in Class 1 section.

[26 marks]

2. The following **Figure 1** will be referred throughout **Question 2**.

Haunch
$b_h = 3$ m

$6°$

Rise $h_r = 1.58$ m

$h = 13.1$ m

Pinned-base

$h = 30$ m

(a) Single portal frame

Rafter:
Axial = 109 kN
Shear = 187 kN

445 kNm

618 kNm

462 kNm

1081 kNm

1101 kNm

5737 mm

621 kNm   620 kNm

5826 mm

83 kN

84 kN

270 kN

271 kN

(b) Bending moment diagram (include EHF)
Figure 1

(a). Consider a single symmetric portal frame with pinned bases as in **Figure 1**. From the initial analysis, the reactions are as tabulated in **Table 1** below. Check the significance of the initial sway imperfection. If the initial sway imperfection is significant, determine the equivalent horizontal forces (EHF).

[18 marks]

Table 1

	Left column (kN)		Right column (kN)		Axial force in rafter (kN)
	H_{Ed}	V_{Ed}	H_{Ed}	V_{Ed}	N_{Ed}
Reactions	74	241	−74	241	97

(b). Evaluate the sensitivity of the following rafter section to the effects of deformed geometry (2nd order effects). All the design information and data are shown in **Table 2** and **Figure 1**.

[16 marks]

Table 2

Rafter section size: $533 \times 210 \times 101$ UKB S355
Section properties:

h	: 536.7 mm	d	: 476.5 mm	I_z	: 2,690 cm^4
b	: 210 mm	A	: 129 cm^2	I_T	: 101 cm^4
t_w	: 10.8 mm	$W_{el,y}$	: 2,290 cm^3	I_W	: 1.810 dm^6
t_f	: 17.4 mm	$W_{pl,y}$	: 2,610 cm^3	i_y	: 219 mm
r	: 12.7 mm	I_y	: 61,500 cm^4	i_z	: 45.7 mm
h_w	: 501.9 mm	E	: 210 GPa		

Given the displacement at the top of the columns under a notional horizontal force (NHF) = 7.2 mm

(c). By assuming the rafter in **Figure 1** is in **Class 1** section, check the cross-sectional resistance of the rafter for *bending moment* and *shear*. Use rafter size in **Question 2 (b)**.

[16 marks]

-oooOOOooo-