

**THE UNIVERSITY OF BOLTON**

**SCHOOL OF ENGINEERING**

**BENG (Hons) CIVIL ENGINEERING**

**SEMESTER ONE EXAMINATION 2022/2023**

**STRUCTURAL PLANNING (Option)**

**MODULE NO: CIE6010**

Date: Wednesday 11<sup>th</sup> January 2023

Time: 14:00 – 17:00

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**INSTRUCTIONS TO CANDIDATES:**

This is an OPEN BOOK Examination.  
You may bring your own notes and documents into the examination room.

There are **THREE** questions. Marks for each question and its parts are shown in brackets.

Attempt **ALL** questions.

Sketches should be neat and approximately to scale.

Graph paper is provided.

All answers are to be written in the answer book or on the graph paper provided. Pre-prepared material will not be accepted.

This examination paper carries a total of 100 marks.

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### **Background information**

1. Refer to the sketches (Figures 1 and 2 on page 5) and structural information provided. It is proposed to construct a four-storey healthcare building with a footprint of 36m x 60m.

2. The upper storeys of the proposed building will comprise a structural frame of either steel or concrete. The developer wants to investigate both options. For the purposes of this exam you must only consider either steel or concrete. The choice is yours.

**Do not consider both steel and concrete.**

3. At ground level there is internal car parking. The approximate location of the access to the car park is shown in Figure 1. The developer requires that the car park be designed to provide the maximum possible number of parking bays. There are no restrictions on column locations at ground level.

4. At 1<sup>st</sup> floor level and 2<sup>nd</sup> floor level, the architect has decided on the setting out of the columns within the offices/consulting rooms. The columns are to be positioned at approximately 6.0m centres both longitudinally and transversely.

5. At 3<sup>rd</sup> floor level it is proposed to construct a sports hall. At this level, there must be a clear uninterrupted space and no internal columns. External columns may be spaced to suit the structural framing. The outline of the roof structure has not yet been decided and so you are free to propose to the architect a flat, sloping or any other shaped roof.

6. The location of the services and stair/lift zone has not yet been decided. This will be confirmed at a later date and should not be considered at this stage. The perimeter bracing/shear walls can be located to suit your structural requirements. The bracing/shear walls must provide overall lateral stability for the building in all directions.

7. A horizontal wind force of **1.2 kN/m<sup>2</sup>** acts on the building.

8. Assume permanent actions (dead load) on typical floor (includes services, ceiling, raised floors, etc) = **5 kN/m<sup>2</sup>**

Variable action (imposed load) on floors = **5 kN/m<sup>2</sup>**

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**Question 1**

Produce preliminary general arrangement sketches showing the following:

- (a) A plan of the building at 2<sup>nd</sup> floor level showing the structural layout of beams, internal and external columns and floor slab or decking etc. (10 marks)
- (b) A plan of the building at 1<sup>st</sup> floor level showing the structural layout of beams, transfer beams, internal and external columns and floor slab or decking etc (make it clear in your plan which beams are transfer beams). (15 marks)
- (c) A transverse section through the building showing the arrangement of the columns, beams and transfer beams etc. At roof level, indicate the chosen structural form and its structural layout but do not provide structural calculations for the roof structure. (10 marks)
- (d) Justify the section sizes chosen for the main structural elements at 2<sup>nd</sup> floor level (shown in part (a) above) making use of “rule of thumb” and brief preliminary structural design calculations. (15 marks)

**Question 2**

Using notes and sketches show how the whole building structure (including the roof) will sustain the applied horizontal wind loads.

Include calculations to justify the size of the member that carries the greatest wind-induced force if bracings are to be used for lateral stability.

If shear walls are to be used for lateral stability, **only** check for twisting, overturning and soil pressure under the base.

Ignore the design of the foundations for any shear walls or bracing.

(20 marks)

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**Question 3**

- (a) Produce a preliminary sketch layout plan at ground floor level showing your proposed access arrangements for the car park and the car park layout. Show the locations of structural columns, vertical bracing/shear walls and car parking bays and state clearly the maximum number of spaces that your scheme provides.

**(20 marks)**

- b) Sustainability Requirements:

Prepare a one-page report to discuss how your structural design helps satisfy the requirements of **Sustainability** for the building?

In your report you may cover/discuss the following for the sustainability:

- Minimise waste and CO2 emissions (footprint)
- Provide possibility for recycling

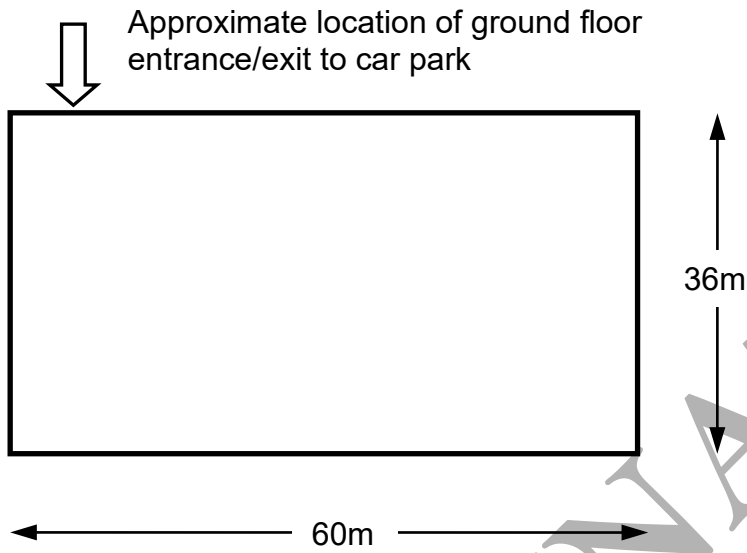
**(10 marks)**

**END OF QUESTIONS**

**Reference drawings follow over the page...**

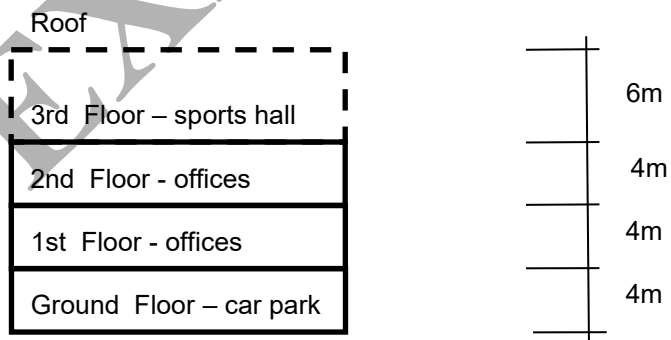
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Plan showing the footprint of the proposed 4 storey building

Figure 1



Sectional elevation showing the 4 storey building

Figure 2

END OF PAPER