

**THE UNIVERSITY OF BOLTON**

**SCHOOL OF ENGINEERING**

**BEng (Hons) CIVIL ENGINEERING**

**SEMESTER 1 EXAMINATIONS 2023/2024**

**ADVANCED CONCEPTUAL DESIGN AND  
STRUCTURAL PLANNING (Option)**

**MODULE NO: CIE6026**

Date: Friday 12<sup>th</sup> January 2023

Time: 10:00 – 1:00pm

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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.

Sketches should be neat and approximately to scale.

There are THREE questions. Marks for each question are shown.

Attempt ALL questions

A4 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.

Total 100 marks for the paper.

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### Background information

1. Refer to the sketches (Figures 1 and 2) and structural information provided. It is proposed to construct a commercial building with footprint 36m x 36m. All floors will be occupied by offices apart from the ground floor which will provide 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 number of parking bays.

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. The architect has decided on the setting out of the *upper* columns (running from 2<sup>nd</sup> floor level to the roof). These are to be provided at approximately 6.0m centres both longitudinally and transversely. The lower columns between ground floor and 2<sup>nd</sup> floor levels must be at 9.0m centres. The setting out of the upper columns therefore differs from the setting out of the lower columns of the building. A transfer deck will be needed at 2<sup>nd</sup> floor level.

4. The perimeter cladding of the whole building is non-structural and so the structure will need to extend its support to the edges of the building. The final choice of cladding has not been made. It will be either non-structural masonry or a "rainscreen system". For the purposes of this exam you must only consider either non-structural masonry or a "rainscreen system". The choice is yours. Do not consider both types of cladding.

5. 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

6. **Loading data** (Unfactored):

Permanent actions (dead load) on typical floor (includes services, ceiling, raised floors, etc) = 3.7 kN/m<sup>2</sup>

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

A horizontal wind force of 1.26 kN/m<sup>2</sup> acts on the building.

Any other forces or loads can be estimated or calculated.

**Omit from consideration**

Design of foundations.

**Please turn the page**

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**Answer ALL Questions**

**Question 1**

Produce preliminary general arrangement sketches (i.e. annotated stick drawings) showing the following:

(a) A plan of the building at 3<sup>rd</sup> floor level showing the structural layout of beams, internal and external columns and floor slab or decking etc. Show clearly the locations of bracing or shear walls.

(b) A plan of the building at 2<sup>nd</sup> floor level showing the structural layout of beams, transfer beams, internal and external columns, bracings, and floor slab or decking etc (make it clear in your plan which beams are transfer beams).

(c) A transverse section through the building showing the arrangement of the columns, beams and transfer beams. Display the load path acting in the structural elements.

(d) Justify the section sizes chosen for the main structural elements at 3<sup>rd</sup> floor level (shown in part (a) above) making use of “rule of thumb” or brief preliminary structural design calculations.

**(50 marks)**

**Question 2**

Produce a preliminary sketch layout plan at ground floor level showing the car park layout and its access arrangements.

Show the locations of structural columns, car parking bays and state clearly the maximum number of car spaces that your scheme provides.

**(20 marks)**

**Question 3**

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

Include calculations to justify the size of the member that carries the greatest wind-induced force or bending moment. Ignore the design of the foundations.

**(20 marks)**

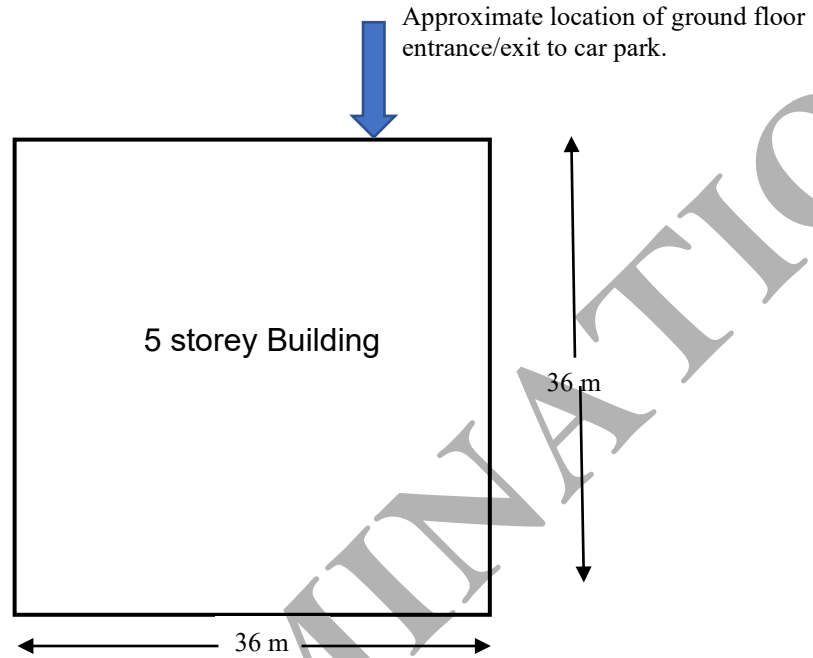
**Question 4**

List three possible sources of hazards and risks which might occur during the service of the car park, and critically assess with discussion the methods and precautions taken to eliminate or minimise the risks associated with the hazards.

**(10 marks)**

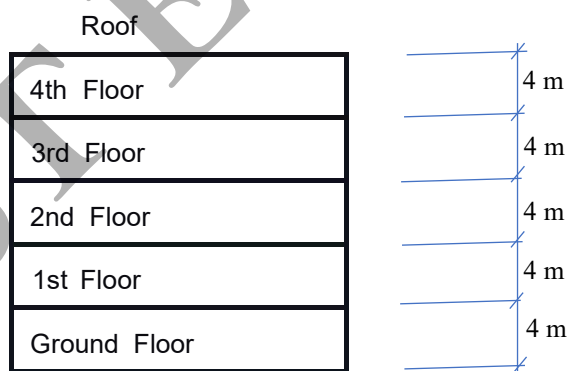
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Plan showing the footprint of the proposed 5 storey building

Figure 1



Sectional elevation showing the 5 Storey building

Figure 2

**END OF QUESTIONS**  
**END OF PAPER**