UNIVERSITY OF JOHANNESBURG

PROGRAM: **BSc CONSTRUCTION STUDIES**

SUBJECT: **BUILDING STRUCTURES 2**

CODE: **SCTCOY2**

DATE: **09 NOVEMBER 2019**

DURATION: **3.5 Hours**

TOTAL EXAM MARKS: **140 Marks (SUPPLEMENTARY EXAM)**

EXAMINER: **DR. E.E. AGBENYEKU**

MODERATOR:

INSTRUCTIONS TO STUDENTS

1. Answer all questions
2. Carefully read the questions. You will be penalized if your answers are not properly structured and numbered
3. SCTCOY2 is a practical module and each main heading must be supported by a practical example where requested
4. Use a calculator where you find the need
5. Plain numbers/values i.e., 1 or 5 does not send any message; please provide units and justifications as outputs for every value as appropriate

NOTE: You are allowed to flexibly respond and or react to the questions based on the knowledge and understanding you have gathered on building structures from everyday experiences and in the classroom as covered in this module.

Question 1 [35 Marks]

As a building scientist/technologist, studying and understanding the components of a building, the forces acting on a building structure, and how building elements and building as an integral unit behave under myriad loading effects is very crucial to ensuring the construction of the best quality building. It entails understanding the simple technologies of building structure design, construction and maintenance, with paramount interest in the structural performance of the building. Considering that you occupy a position of building specialist for the City of Johannesburg and you are the leader of a joint task team of construction specialist; there is bound to always be intensive arguments on diverse issues with respect to building design and construction principles, including problems like location of sites, choice of materials, construction methods amongst others. As a leading specialist with scientific and technical knowledge on building structures and their interactions with loadings/forces and the elements, assist your team of experts in addressing or resolving the following questions:

With all that is already known about building structures/ buildings in general, certain design principles, construction methods and factors must be adhered to in order to ensure the erection of a safe structure.

(i) Based on this last paragraph briefly explain the importance of a building structure. **[5]**

(ii) In order that a structure fulfills its functional requirements, especially by providing safety to occupants and their properties, certain aspects must be

considered in the design of the structure. Briefly explain what a safe structure must be based on which must be given primary attention. **[5]**

(iii) From your knowledge of design principles of a building, select any two (2) aspect of the design principle and briefly explain its relevance to the integrity of a building structure. **[4]**

(iv) The pictorial presentation in **Figure A** below shows a well built and structured uncompleted building which was impacted by a major hazard. From in-situ assessment of the disaster site and wreckage, it was discovered that the building was structurally good but the location was somewhat waterlogged with a weak/loose soil. In the event of an earth tremor, the building subsided unevenly into the ground. Briefly explain what you suggest was fundamentally wrong. **[6]**

Figure A

(v) Still applying your understanding of the design principles of a building, elaborate on what it means when it is said that a "*building needs a coherent structure*". **[5]**

(vi) The pictorial view in **Figure B** below displays a structure being erected in a low lying area/ waterlogged terrain. Explain the dangers of constructing a building in such a terrain and then explain the relationship between a building elevation and the foundation/stilts since we can see concrete stilts being cast on pad footings to raise the floor level. **[6]**

Figure B

(vii) Briefly explain the dangers of a poor drainage system to a building structure, also stating what areas a proper drainage plan should address. **[4]**

Question 2 [35 Marks]

For areas with a minimum required live load exceeding 100 lb/ft^2 and for passenger car garages, live loads on columns supporting more than one floor may be decreased 20%. Except for the preceding cases, a reduced live load *L*, lb/ft^2, may be computed from an equation.

(i) Considering that the unreduced live load is recorded as 120 lb/ft^2 with an influence area for structural effects of 10 ft^2. What becomes the value of the reduced live load? ***Correctly select and apply the right equation from the formulae hints***. **[10]**

(ii) The reduced live load however, should not be less than 0.5*Lo* for members supporting one floor or 0.4*Lo* for members supporting two or more floors. Therefore, comment on the calculated value from (i) in relation to 0.5*Lo* and 0.4*Lo*. **[5]**

(iii) Tensile or compressive stress normal to a plane is usually denoted "**normal stress**" or "**direct stress**". As such, compute the stress in a cylindrical stilt with a normal kip and an added force of 10kN acting on the stilt with diameter of 10 mm which tends to pull the two segments of the stilt. ***Correctly select and apply the right equation from the formulae hints***. **[8]**

(iv) Make a comment on what type of direct stress is at play in (iii). **[2]**

(v) From (iii) consider a load of *30,000 N* is acting on the same cylindrical stilt of 10 mm diameter and with *contracted/dressed size* of 8 mm diameter. Calculate the direct stress. ***Correctly select and apply the right equation from the formulae hints***. **[8]**

(vi) Make a comment on what type of direct stress is at play in (v). **[2]**

Question 3 [35 Marks]

In recent applications, the protection of structures against hazards has become very important. In as much as all buildings are subject to hazards such as hurricanes, earthquakes, flood, fire, and lightning strikes, both during and after construction, building designers and contractors have the responsibility of estimating the risks of these hazards and the magnitudes of the consequences should the events be realized. With your understanding of this concept, answer the following questions:

(i) After the risk of a hazard has been assessed, the building designers and contractors, guided by building-codes, design standards, zoning-codes, and health-agency specifications as well as exercising their best judgment, should

decide on an acceptable level for the risk. Briefly explain why the best judgement of building designers and contractors is important in deciding acceptable risk levels. **[7]**

(ii) Stringent design criteria are often applied in conditions specific to buildings in extreme climates or in areas exposed to natural hazards, such as high winds, earthquakes, floods, landslides, and lightning. In knowledge of these, highlight three (5) other cases for buildings under which stricter criteria should also be used. **[5]**

(iii) In the design life of buildings, it is important to note that for natural phenomena the design criteria may be based on the probability of occurrence of extreme conditions, as determined from statistical studies of events in specific localities. On this note, what are these probabilities often expressed as? **[5]**

(iv) If for instance, the mean recurrence interval of a wind of 45 miles/ hour or more is recorded for Johannesburg as 20 years, briefly state what this means after a building has been erected in Johannesburg. **[5]**

(v) Bearing in mind the scenario in question (iv), if the building was assumed to have a 20 year active life, briefly explain how best designers/ contractors should logically design the building. **[5]**

(vi) It is a known fact that the design of buildings for both normal and emergency conditions should always incorporate a safety factor against failure. In respect of this, highlight four (4) ways in which the magnitude of the safety factor should be selected. **[8]**

Question 4 [35 Marks]

In recent applications, Energy efficiency has become a common terminology, however without clear understanding of the underlying concepts it will be useless propagating it. The concept of energy efficiency is based on the concept of energy saving and money rebates. With your understanding of this concept, answer the following questions:

(i) Briefly explain how energy efficient building fit in the concept of energy efficiency by either indicating an energy saving option or simply how a building structure can positively or negatively contribute to energy efficiency. **[5]**

The City of Johannesburg launched 500 RDP housing project in 2019 for 2020 completion. The houses are three bedroom suits, one lounge with kitchen 4 plate stove, one water boiler and two entrance/exit doors.

From your survey results, the following findings were made: each house switch on their **indoor lights** [4] for 360 minutes and 720 minutes for **outdoor** [2], **stove** is used for 3 hours, **water boiler** for 2 hours, **TV** for 6 hours, **microwave** for 1.5 hours, **iron** for 2

hours, **washing machine** for 3.5 hours, **kettle** for 60 minutes, **heater** for 6 hours, **fridge** for 24 hours. The energy consumption for the appliances are as follows:

Item	**Consumption [w/h]**
Lights	100
Stove	4500
Heater	1000
Fridge	40
Microwave	1000
Kettle	2000
TV	80
Iron	1500
Washing machine	2300
Water boiler	3500

(ii) Calculate the total energy requirements for the 500 RDP houses in kW and in MW of power. **[20]**

(iii) Freely comment on what energy saving tips you can offer to the residents of these 500 RDP houses in order to reduce the total energy requirements of their houses. **[5]**

(iv) Assuming the residents of these 500 RDP houses adopted your energy saving tips and cut down their usage times of the respective appliances by half (1/2). What will the new total energy requirements for the 500 RDP houses in kW and MW of power be? **[5]**

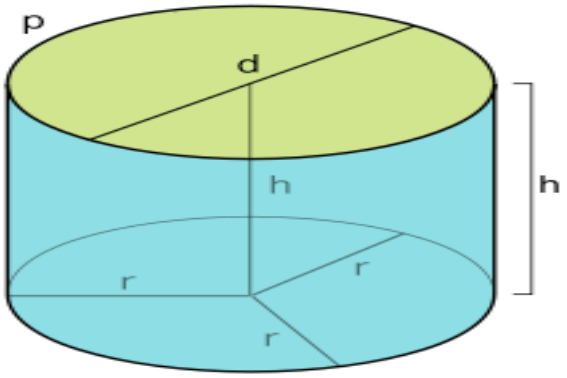
TOTAL = 140 Marks

FORMULAE HINTS

$\varepsilon_t = dr / r$; $\varepsilon_l = dl / L$; $\mu = - \varepsilon_t / \varepsilon_l$; $\tau = F_p / A$; $\sigma = F_n / A$

$$L = \left(0.25 + \frac{15}{\sqrt{A_f}}\right) L_o$$

The Cylinder



Diameter $d = 2 \cdot r$

Perimeter $p = 2 \cdot \pi \cdot r$

Base Area $A_B = \pi \cdot r^2$

Lateral Surface $A_L = 2 \cdot \pi \cdot r \cdot h$

Surface $A_S = 2 \cdot \pi \cdot r^2 + 2 \cdot \pi \cdot r \cdot h$

$A_S = 2 \cdot \pi \cdot r \cdot (r+h)$

Volume $V = \pi \cdot r^2 \cdot h$

- *a kip* is an imperial unit of force - it equals *1000 lb_f (pounds-force)*
- ***1 kip*** *= 4448.2216 Newtons (N) = 4.4482216 kilo Newtons (kN)*
- ***Lo*** = unreduced live load, lb/ft^2
- ***AI*** = influence area, or floor area over which the influence surface for structural effects is significantly different from zero.