MACHAKOS UNIVERSITY

University Examination 2019/2020

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECV 205: CIVIL ENGINEERING MATERIALS I

DATE: 17/12/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

Use well labeled and neat diagrams where applicable.

QUESTION ONE (30 MARKS)

a) Define *initial set* and *final set.* Briefly discuss one method used to determine them. (5 marks)

b) As a materials engineer in charge of designing concrete mix and facing the following problems, which admixture would you use in each case during mixing or at the jobsite? (6 marks)

i. There is a large quantity of freshly mixed concrete and the work at the jobsite had to stop because of rain.

ii. More time is expected to be needed for finishing concrete.

iii. The structure is subject to freezing.

iv. Concrete is to be around tightly spaced reinforcing steel.

v. Concrete mix will be hauled a long distance.

vi. High early strength concrete is required, but not necessarily high ultimate strength.

c) Three standard mortar cubes were made using nonpotable water available at the job site, and three others were made using potable water. The cubes were tested for compressive strength after seven days of curing and produced the following failure loads in kg:

Nonpotable water	**Potable Water**

6909	7773
6591	7400
7227	7364

d) Based on these results only, would you accept that water for mixing concrete? Explain why. (4 marks)

e) What type of cement would you use in each of the following cases? Why? (5 marks)

i. Construction of a large pier

ii. Construction in cold weather

iii. Construction in a warm climate region such as the Phoenix area

iv. Concrete structure without any specific exposure condition

v. Building foundation in a soil with severe sulfate exposure

f) Discuss the terms and outline at least five application of paving asphalt (10 marks)

QUESTIONS TWO (20 MARKS)

The Marshall method was used to design an asphalt concrete mixture. A PG 64-22 asphalt cement with a specific gravity (G_b) of 1.031 was used. The mixture contains a 9.5 mm nominal maximum particle size aggregate with a bulk specific gravity (G_{sb}) of 2.696.The theoretical maximum specific gravity of the mix (G_{mm}) at asphalt content of 5.0% is 2.470.Trial mixes were made with average results as shown in the following table:

Determine the design asphalt content using the Asphalt Institute design criteria for medium traffic (Table A). Assume a design air void content of 4% when using Table B.

Asphalt Content (Pb) (% by Weight of Mix)	**Bulk Specific Gravity (Gmb)**	**Corrected Stability (kN)**	**Flow (0.25 mm)**
4.0	2.360	6.3	9
4.5	2.378	6.7	10
5.0	2.395	5.4	12
5.5	2.405	5.1	15
6.0	2.415	4.7	22

Table A

ASPHALT DESIGN CRITERIA FOR MARSHAL MIX DESIGN			
	Traffic Level		
	Light	**Medium**	**Heavy**

	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
VFA,%	70	80	65	78	65	75

Table B

	MINIMUM VMA, Percent		
	Design Air Voids [2]		
Nominal Maximum Particle Size [1]	**3.0**	**4.0**	**5.0**
9.5 mm (3/8 in)	14.0	15.0	16.0
12.5mm (1/2 in)	13.0	14.0	15.0

QUESTION THREE (20 MARKS)

a) The following three mixtures are relevant for a civil engineer in masonry. What are they made of and what are their functions? (10 marks)

i. Mortar

ii. Grout

iii. Plaster

b) A half-block concrete masonry unit is subjected to compression until failure. The outside dimensions of the specimen are 190mm ×190mm× 190mm.The cross section is a hollow square with a wall thickness of 38 mm. The load is applied perpendicular to the hollow cross section and the maximum load is 296 kN. (4 marks)

i. Determine the gross area compressive strength.

ii. Determine the net area compressive strength.

c) A concrete masonry unit has actual gross dimensions of 7.625"×7.625"×7.625". The unit is tested in a compression machine with the following results: (6 marks)

Failure Load= 98000 Lb.

Net Volume=348.1 in^3

i. Is the unit categorized as solid or hollow?

ii. Calculate the gross area compressive strength.

iii. Calculate the net area compressive strength.

QUESTION FOUR (20 MARKS)

a) What do we mean by curing concrete? What will happen if concrete is not cured? (2 marks)

b) Discuss six different methods of concrete curing (12 marks)

c) The design of a concrete mix requires of gravel in dry condition, 582 Kg/m^3 of sand in dry condition, and 157 Kg/m^3 of free water. The gravel available at the job site has a moisture content of 0.8% and absorption of 1.5%, and the available sand has a moisture content of 1.1% and absorption of 1.3%. What are the masses of gravel, sand, and water per cubic meter that should be used at the job site? (6 marks)

QUESTION FIVE (20 MARKS)

a) Aggregates from three sources having the properties shown in the table below were blended at a ratio of 55:25:20 by weight. Determine the properties of the aggregate blend. (6 marks)

Property	**Aggregate 1**	**Aggregate 2**	**Sand**
Coarse aggregate angularity, percent crushed faces	100	87	N/A
Bulk specific gravity	2.631	2.711	2.614
Apparent specific gravity	2.732	2.765	2.712

b) The results of a laboratory experiment to evaluate the effects of a plasticizer are shown below.

	Without Water Reducer	**With Water Reducer**		
		Case 1	**Case 2**	**Case 3**
Cement Content, kg/m3	850	850	850	765
Water Content, kg/m3	465	465	370	419
Slump, mm	50	100	50	50
Compressive Strength, MPa	37.8	38.0	46	37.9

i. Calculate the water/cement in each of the three cases. (2 marks)

ii. Using water reducer, how can we increase the compressive strength of concrete without changing workability? Refer to the appropriate case in the table. (2 marks)

iii. Using water reducer, how can we improve workability without changing the compressive strength? Refer to the appropriate case in the table. (2 marks)

iv. Using water reducer, how can we reduce cost without changing workability or strength? (Assume that the cost of the small amount of water reducer added is less than the cost of cement.). Refer to the appropriate case in the table. (2 marks)

v. Summarize all possible effects of water reducers on concrete. (6 marks)