(The *University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN

UNIVERSITY EXAMINATIONS 2012/2013 ACADEMIC YEAR

FOURTH YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN CIVIL AND STRUCTURAL ENGINEERING

COURSE CODE: CVS 549E

COURSE TITLE: FLOW IN ERODIBLE OPEN CHANNELS

DATE: Monday 14th January 2013 **TIME:** 2.00p.m.-5.00p.m.

INSTRUCTIONS TO CANDIDATES

Attempt ALL Questions in Section A and Any THREE Questions in Section B

Density of water as 1000kg/m^3, density of sediment particle is 2650 kg/m^3, g = 9.81 m^2/s

Relevant tables and figures are provided at the end of the question paper

SECTION A (compulsory)

Question One (22 Marks)

a) Briefly describe the following types of bed forms (6 marks)

i. Ripples
ii. Dunes
iii. Antidunes
iv. Standing waves

b) A quartz particle (D_{50} = 0.05cm) is carried in suspension by a stream which flows into a 100m deep lake where it settles to the bottom. Calculate the length of time required (in min) for the sediment particle to settle from the lake surface to the bottom given kinematic viscosity coefficient, $\upsilon = 1.416 \times 10^{-3}$ NS/m^2 and S_s= 2.65. (5 marks)

c) State and elaborate on any three factors which affect sediment yield in a watershed (3marks)

d) A channel has been designed to convey clear water to a fish hatchery. The flow depth is 0.8m and flow velocity is 0.7m/s. the channel is to be constructed in sand of D_{50} = 1.0 mm, slope = 0.000136. Clear water is admitted to the channel, no material should be scoured from the channel since any sand in the hatchery will result in the instantaneous death of all the fish. Determine if the existing design is adequate to deliver the clear water to the hatchery. Assume, kinematic viscosity coefficient, $\upsilon = 1.0 \times 10^{-6}$ NS/m^2 (8 marks)

Question Two (18 Marks)

a) What is the rate of bed load transport in a river (q_b) with a water slope S= 6.5×10^{-4}, the average depth d= 5.87 m and the width b = 46.52m., the mean particle size; D_{50} = 0.2mm and average velocity is 1.52 m/s. Use Meyer-Peter and Shields Formulae. Neglect bank friction and assume, kinematic viscosity coefficient, $\upsilon = 0.5 \times 10^{-6}$ NS/m^2 and Manning's coefficient, n =0.0212 (10 marks)

b) An irrigation canal is to carry 2.83m^3/sec through soil consisting of coarse alluvial gravel with D_{50} = 5cm. The canal is to be laid along a line having a slope of 0.01 and it may be assumed that the banks will be grassed and protected from scour. Find the width of the canal using critical shear stress as the scour criterion (8 marks)

SECTION B (Attempt any THREE Questions)

Question Three (20 marks)

a) Explain the relationship between water and sediment hydrographs (6 marks)

b) Using permissible velocity method Design a channel to carry 6.91 m^3/sec of water. The channel will be excavated through stiff clay at a channel bottom slope of 0.00318. Assume free board is 20 percent (14 marks)

Question Four (20 marks)

a) Describe the Mechanism of Sedimentation in Reservoirs (7 marks)

b) Briefly Explain THREE ways of sedimentation control in Reservoirs (9 marks)

c) Using Shields' threshold criterion of Fs = 0.056, show that the minimum size of stone that will remain at rest in channel bed of given hydraulic radius R and bed slope S is given by $D \approx 11RS$, where R is the Hydraulic Radius and S is the slope of the channel bed. (4 marks)

Question Five (20 marks)

a) Differentiate between *Wash* load and *Saltation* load (5 marks)

b) The annual suspended-sediment load for River Nile is given as 600 x 10^6 tonnes/year and average annual discharge is Q = 1.0 x $10^3 m^3$/sec. Calculate the Suspended-sediment concentration (3 marks)

c) Compute the total bed-material load (q_t) in an alluvial stream using the formula of Engelund and Hansen. The stream discharge is 105m^3/sec. The channel has a slope of 0.00027, bed width of 46m, flow depth of 2.32 m, side slopes of 2:1, and D_{50} = 0.354mm (12 marks)

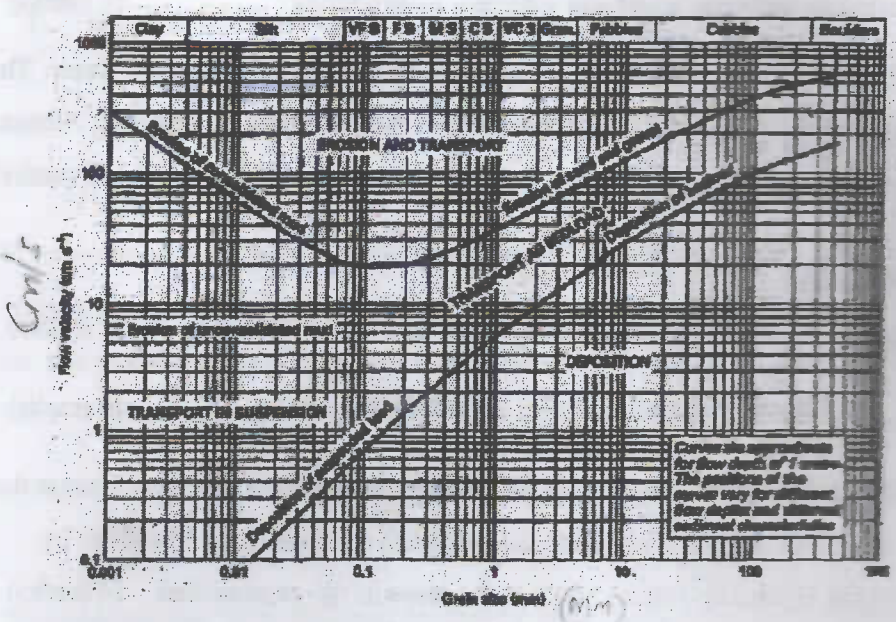
Question Six (20 marks)

a) Describe the mechanism of Aggradation and Degradation in a river Bed (10 marks)

b) A rectangular Canal shall be designed in a terrain where the slope is predetermined and given as S = 0.01. This canal, supposed to carry 22.5m^3/sec of clear water, should be free of scour for all purposes involved. The material analysis gave Quartz gravel with a

representative size of D = 50mm and a Manning's of n = 0.021. What are the dimensions of the rectangular canal? Use threshold velocity as the scour criterion (10 marks)

Figure 1: Critical Velocity / Permissible Velocity Hjulstrom Curve



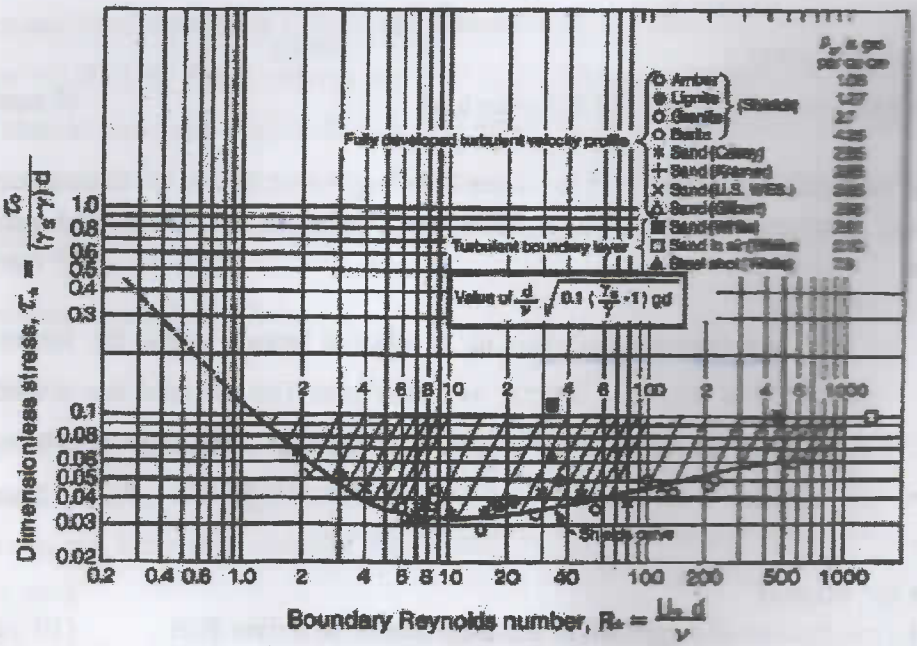


Figure 2: Shields Diagram

Table 1: Mannings values of different bed materials

Material	V, ft/s	n
Fine sand	1.50	0.020
Sandy loam	1.75	0.020
Silt loam	2.00	0.020
Firm loam	2.50	0.020
Stiff clay	3.75	0.025
Fine gravel	2.50	0.020
Coarse gravel	4.00	0.025

Table 2: Recommneded side slopes of variuos materials (after Fortier and Scobey, 1926)

Material	Side slope
Rock	Nearly vertical
Stiff clay	$\frac{1}{2}$ to 1:1
Firm soil	1:1
Loose sandy soil	2:1
Sandy loam	3:1

Table 3: Recommended Permissible velocities (After U.S. Army Corps of Engineers, 1970)

Material	V (m/s)
Fine sand	0.6
Coarse sand	1.2
Earth	
Sandy silt	0.6
Silt clay	1.1
Clay	1.8
Grass-lined earth (slopes < 5 per cent)	
Bermuda grass	
Sandy silt	1.8
Silt clay	2.4
Kentucky Blue grass	
Sandy silt	1.5
Silt clay	2.1
Poor rock (usually sedimentary)	
Soft snadstone	2.4
Soft shale	1.1
Good rock (usually igneous or hard metamorphic)	6.1

Engelund and Hansen	Shields formulae	Meyer-Peter equation
$q_t = 0.05V^2\left(\frac{d_{50}}{g(s_s-1)}\right)^{0.5}\left(\frac{\tau_b}{\gamma_w(s_s-1)d_{50}}\right)^{1.5}$	$q_b = \frac{10q\bar{S}(\tau_0 - \tau_c)}{\rho g(s_s-1)^2 D_{50}}$	$q_b = [250\, q^{2/3}\, S - 42.5\, D_{50}]^{3/2}$
Shields parameter $\tau_* = \frac{\tau_0}{\rho g(S-1)D}$	Settling velocity $\omega_s = \frac{1}{18}\frac{(\rho_s - \rho_w)gD^2}{\upsilon}$	