

**MASTER OF CIVIL ENGINEERING EXAMINATION 2024**  
(1<sup>st</sup> Semester)

**SLOPE STABILITY AND EARTH DAMS (SMFE)**  
(Paper III)

Time: Three Hours

Full Marks 100

Use a separate Answer-Script for each part

Question No.	Answer any Four questions	Marks																																																	
Assume the reasonable value of the parameters, if not supplied																																																			
1	(a) What is called as slope failure? What are the probable causes of slope failure? How the slope stability problems are classified as per classical theory and time dependency?	2+3+3=8																																																	
	(b) What is residual shear strength of a soil sample? How it can be obtained? Which type of soil samples are normally considered for obtaining the residual strength?	2+2+2=6																																																	
	(c) Determine the Factor of Safety (FoS) of infinite slope in sand with angle of shearing resistance $\phi'$ and surface slope $\beta$ .	5																																																	
	(d) Derive the expression for Stability Number in seepage and no seepage (parallel to ground) condition.	3+3=6																																																	
2	(a) Distinguish between total stress method and effective stress method of slope stability analysis. Indicate the shear strength parameters required for each type of analysis.	6+6=12																																																	
	(b) Derive factor of safety through Bishop's method for slope stability analysis considering all types of forces on an elementary slice.	13																																																	
3	(a) It is required to make a 6.5m deep cut in a c- $\phi$ soil. The slope is restricted to be $42^\circ$ and the soil has $C_u = 3.6 \text{ t/m}^2$ , $\phi = 11.5^\circ$ and $\gamma = 1.82 \text{ t/m}^2$ . Find the factor of safety and estimate the critical height for the slope in this soil, using the following table for stability number.	10+8=18																																																	
	<table><tr><th><math>\phi^\circ \backslash \beta^\circ</math></th><th>0</th><th>5</th><th>10</th><th>15</th><th>20</th><th>25</th></tr><tr><th>90</th><td>0.261</td><td>0.239</td><td>0.218</td><td>0.199</td><td>0.182</td><td>0.166</td></tr><tr><th>75</th><td>0.219</td><td>0.195</td><td>0.193</td><td>0.152</td><td>0.134</td><td>0.117</td></tr><tr><th>60</th><td>0.191</td><td>0.162</td><td>0.138</td><td>0.116</td><td>0.097</td><td>0.079</td></tr><tr><th>45</th><td>0.170</td><td>0.136</td><td>0.108</td><td>0.083</td><td>0.062</td><td>0.044</td></tr><tr><th>30</th><td>0.156</td><td>0.110</td><td>0.075</td><td>0.046</td><td>0.025</td><td>0.009</td></tr><tr><th>15</th><td>0.145</td><td>0.068</td><td>0.023</td><td>-</td><td>-</td><td>-</td></tr></table>	$\phi^\circ \backslash \beta^\circ$	0	5	10	15	20	25	90	0.261	0.239	0.218	0.199	0.182	0.166	75	0.219	0.195	0.193	0.152	0.134	0.117	60	0.191	0.162	0.138	0.116	0.097	0.079	45	0.170	0.136	0.108	0.083	0.062	0.044	30	0.156	0.110	0.075	0.046	0.025	0.009	15	0.145	0.068	0.023	-	-	-	
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	(b) Draw free body diagram for the elementary slice using Lowe and Karafiath Method (1960), and Spencer Method (1967).	3½x2=7																																																	
4	A homogeneous earth dam resting on impervious foundation is 10m high with a free board 2m was constructed with isotropic soil mass. It has a crest width of 3m, with U/s and D/s side slopes of 3(H):1(V) and 2.5 (H):1(V) respectively. Estimate the Factor of Safety in total stress condition, for the slip circle passing through toe, with a radius 1.20 times of the dam height. Provide centre of the slip circle graphically. Assume $C_u = 2.0 \text{ t/m}^2$ , $\phi = 5.5^\circ$ and $\gamma = 1.78 \text{ t/m}^2$ .	25																																																	
5	(a) Write and explain the Laplacian equation regarding two-dimensional seepage. What are the assumptions for developing the 'Laplacian Equation' regarding seepage flow?	2+3=5																																																	
	(b) Define 'Isotropic Soil'. Write down the steps and derive the equation for determination of seepage discharge through 'Isotropic Soil'; also write down the equation for the same through 'Non-Isotropic Soil'.	2+6+2=10																																																	
	(c) What is 'Phreatic Line'? Determine the phreatic line, graphically, for the earth dam (details given below) with a horizontal filter of length equal to 25m, provided inward from the downstream toe of the dam, also determine the discharge passing through the dam. The earth dam made of homogeneous and isotropic soil, which have the following details: Coefficient of permeability of dam material = $4.5 \times 10^{-4} \text{ cm/sec}$ ; Level of top of dam= 200.0m; Level of deepest river bed = 173.0m; H.F.L. of reservoir= 198.0m; Width of the top of dam= 4.0m U/s Slope= 3(H):1(V); D/s Slope= 2(H):1(V)	2+8=10																																																	