Ref. No. :Ex/PG/CE/T/128D/2024

# M. E. CIVIL ENGINEERING FIRST YEAR SECOND SEMESTER EXAM – 2024

## ANALYTICAL GEO MECHANICS

**TIME: Three Hours** **FULL MARKS: 100**

*Answer all the questions*

*Assume any data if needed, reasonably*

| | | | |
|---|---|---|---|
| **1.** | **(a)** | Split the following stress tensor into hydrostatic stress tensor and deviatoric stress tensor. $[\sigma_{ij}] = \begin{bmatrix} 18 & 0 & 24 \\ 0 & -50 & 0 \\ 24 & 0 & 32 \end{bmatrix}$ kPa | **2** |
| | **(b)** | Determine the I-invariants and J-invariants of the deviatoric stress tensor. | **6** |
| | **(c)** | Find the equivalent uniaxial stress for the above stress tensor. | **2** |
| **2.** | **(a)** | What is Haigh-Westergaard stress space?What are the significances of different stress invariants in Haigh-Westergaard stress space? | **8** |
| | **(b)** | What is Bauschinger effect? Draw a typical stress-strain curve reflecting the Bauschinger effect. | **4** |
| | **(c)** | In case of elastoplastic loading explain the process of finding the total strain. | **8** |
| **3.** | **(a)** | Explain the effect of hardening modulus on the stress strain curve. | **4** |
| | **(b)** | What is flow rule? Write down the loading-unloading condition and consistency condition for the following cases: i) Elastoplastic Elastic Unloading, ii) Elastoplastic Neutral Loading, and iii) Elastoplastic Loading | **8** |
| | **(c)** | For the following stress state derive the expression for Von Mises and Tresca yield citeria $[\sigma] = \begin{bmatrix} \sigma_x & \tau_{xy} & 0 \\ \tau_{xy} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ | **8** |
| **4.** | **(a)** | What is critical state soil mechanics (CSSM)? What are the two 2D spaces relevant to CSSM? | **4** |
| | **(b)** | What is the difference between over consolidation ratio and yield stress ratio? | **2** |
| | **(c)** | Show the NCL, CSL, COCRL, LOC, HOC in a $v - \ln p'$ diagram. | **6** |
| | **(d)** | Prove that $C_c = 2.303\lambda$ and $m_v = \frac{\lambda}{v_o p'}$ | **8** |
| **5** | **(a)** | Draw and explain the $e - \tau - \sigma'$ plot in case of OC soil for CU and CD test. | **7** |
| | **(b)** | Write a short note on tensile failure zone. | **3** |
| | **(c)** | "Critical state: the ultimate state" – with proper diagram prove the statement. | **10** |
| **6** | **(a)** | Draw the yield curve, ESP, CSL in $v - q - p'$ space for drained loading and LOC soil. | **3** |
| | **(b)** | Define SBS. Write the equation of SBS for Cam Clay Model. Express this equation in terms of independent paramaters. | **7** |