Ref . No.: Ex/PG/ME/T/1210J/2018

M.E. MECH. ENGG. 1ST YR. 2ND SEM. EXAM., 2018
THEORY OF PLASTICITY

Full Marks 100 *Answer any five* Duration= 3 hr

1. For an elastic-perfectly plastic material under tension, use "radial return" algorithm to determine the stress ($\boldsymbol{\sigma}$) and the tangent stiffness matrix ($\boldsymbol{C}_t$) for a strain increment $\Delta\boldsymbol{\varepsilon} = [\xi \quad -\nu\xi \quad -\nu\xi \quad 0 \quad 0 \quad 0]^T$, where $\xi = 0.0006$. Additionally determine the total strain over the solution and the plastic strain increment for the step.
   The stress from the last converged substep is $\boldsymbol{\sigma}^0 = [80 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0]^T$.
   The material properties (symbols in their usual meanings) are $E = 200\ GPa$, $\nu = 0.3$, $\sigma_y = 200\ MPa$.
2. Two cylinders, one solid and another hollow, with $r_i = 25mm$ and $r_o = 35mm$, are in an interference fit of $1mm$. Determine the stress distribution for both cylinders in radial and tangential directions. Given $E = 200GPa$ and $\sigma_y = 200MPa$. The material shows elastic-perfectly plastic behavior.
3. From the basic equations of plane strain deformation in plasticity, derive Henky's first and second theorems.
4. Following questions carry equal marks-
   a. Derive the instability criteria of a thin pressure vessel under plastic deformation.
   b. Determine the instability pressure for thin pressure vessel with the following constitutive relation-
   $$\bar{\sigma} = 1000(1 - \exp(-20\bar{\varepsilon}))$$
5. Following questions carry equal marks-
   a. Derive Hill's criteria for maximum dissipation.
   b. Write down the expressions for the equivalent stress and strain for von-Mises criteria and determine the components of the plastic strain rate if stress $\boldsymbol{\sigma} =$ $[120\ 50\ 50\ 35\ 25\ 60]^T$MPa and equivalent plastic strain rate $\dot{\lambda} = 0.002/s$.
6. Following questions carry equal marks-
   a. Show that the stress invariants remain constants over change of coordinates.
   b. Write short notes on the following-
      i. Green's strain
      ii. True strain
      iii. Strain hardening
      iv. Deviatoric stress
      v. Slip lines.