Unit 5
Advanced topics in bending of beams

2 marks questions and answers

1. What do you mean by unsymmetrical bending
   A. If the plane of loading or that of bending, does not lie in (or parallel to) a
      plane that contains principal centroidal axis of the cross section, the
      bending is called unsymmetrical bending.

2. What are the reasons for unsymmetrical bending?
   A. Following are the two reasons of unsymmetrical bending
      (i). The section is symmetrical (viz. rectangular, circular, I-section) but
      the load line is inclined to both the principal axes.
      (ii). The section itself is unsymmetrical (viz. angle section or channel
      section vertical web) and the load line is along any centroidal axis.

3. Distinguish between symmetrical and unsymmetrical section of beams.
   A. If the section is symmetrical, the principal axes are along the axes of
      symmetry.
      If the section is unsymmetrical, the plane of loading doesn’t lie in a plane
      that contains the principal centroidal axis of cross section.

4. How will you calculate stress due to unsymmetrical bending?
   A. The resultant bending stress at the point p(u, v) due to unsymmetrical
      bending is given by,
      \[ \sigma_b = \frac{M_u}{l_{uv}} + \frac{M_v}{l_{uv}} \]
      \[ = \frac{M \sin \theta}{l_{uv}} + \frac{M \cos \theta}{l_{uv}} \]

5. Define principal moment of inertia.
   A. The perpendicular axis about which the product of inertia is zero is called
      principal axes and moment of inertia with respect to this axis is called
      principal moment of inertia.

6. Write the assumptions made in Winkler-Bach theory.
   A. 1. Plane sections (transverse sections) remain plane during bending.
      2. The material obeys Hooke’s law (limit of proportionality is not
         exceeded).
      3. Radial strain is negligible.
      4. The fibres are free to expand or contract without any constraining
         effect from the adjacent fibres.

7. Write the Winkler – Bach formula for a curved beam.
A. The bending stress for a curved beam at a distance \( y \) from centroidal axis is given by,
\[
\sigma = \frac{M}{AR} \left[ 1 + \frac{R^2}{h^2} \times \frac{y}{R+y} \right]
\]
Where, 
- \( R \)=Radius of curvature
- \( A \)=Area of cross section
- \( M \)= Bending moment
- \( h^2 \)= constant for cross section

8. Write the expression for position of neutral axis in case of curved beams.
A. 
\[
y = -\frac{R h^2}{R^2 + h^2}
\]
Where, 
- \( h^2 \)= constant for a cross section
- \( R \)= Radius of curvature
- \( y \)= position of neutral axis
- -ve sign indicates that neutral axis is located below the centroidal axis.

9. Write down the expression for principal centroidal moments of inertia.
A. 
\[
I_{UU} = \frac{I_{yy} + I_{xx}}{2} + \sqrt{\left(\frac{I_{yy} - I_{xx}}{2}\right)^2 + I_{xy}^2}
\]
\[
I_{VV} = \frac{I_{yy} - I_{xx}}{2} - \sqrt{\left(\frac{I_{yy} - I_{xx}}{2}\right)^2 + I_{xy}^2}
\]
\[
I_{UU} + I_{VV} = I_{XX} + I_{YY}
\]

10. What is the shape distribution of bending stress in curved beams?
A. Hyperbolic

11. What is the nature of stress in the inside section of a crane hook?
A. Tensile.

12. What is the most suitable section for a crane?
A. Trapezoidal.