Problems Based on Torsion

2005–2006 (Sem. I) (TME101)

1. What do you mean by polar modulus and torsional rigidity?
2. The diameter of a shaft is 20 cm. Find the safe maximum torque which can be transmitted by the shaft if the permissible shear stress in the shaft material be 4000 N/cm^2 and permissible angle of twist is 0.2 degree per meter length. Take G = 8 × 10^6 N/cm^2. If the shaft rotates at 320 r.p.m what maximum power can be transmitted by the shaft?

2005–2006 (Sem. II) (TME201)

1. What do you mean by the terms; Pure - Torsion and Torsional rigidity?
2. A solid circular shaft is to transmit 160 kW at 180 rpm. What will be the suitable diameter of this shaft of permissible stress in the shaft material should not exceed 2 × 10^6 Pa. and twist per unit length should not exceed 2°. Take G =200 GPa.

2006–2007 (Sem. II) (TME201)

1. Derive the torsion formula.

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}.$$

Enumerate the assumptions that are made in deriving this formula.

2. A solid circular shaft transmits 75 kW power at 180 rpm. Calculate the shaft diameter if the twist in the shaft is not to exceed 1 degree in 2 m length and shear stress is limited to 50 MN/m^2. Take modules of rigidity G = 100 GN/m^2.

2006–2007 (Sem. II) (ME201)

1. A solid shaft of diameter 10 cm, transmits 10 kW power at 1500 R.P.M. Find the maximum shear stress in the shaft. If the diameter is increased by 10%, how much power may be transmitted by the shaft without charging the maximum shear stress in the shaft?

2006–2007 (Sem. I & II) (TME101/TME201) [SCOP]

1. Stating the assumptions, derive torsion equations:

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}.$$

Where T = Twisting moment, J = Polar moment of Inertia, τ = Shear stress at radius R, R = Radius of shaft, G = Modulus of rigidity, θ = Angle of twist, l = length of shaft.

2007–2008 (Sem. I) (TME101)

1. A solid shaft of 200 mm diameter has the same cross-sectional area as that of a hollow shaft of the same material with inside diameter of 150 mm. Determine the ratio of the power transmitted by the two shafts at the same speed.

2007–2008 (Sem. II) (TME201)

1. Design a circular solid staff to transmit 80 kW power at 200 rpm, if the twist in the shaft is not to exceed 2° in 3 m length of the shaft and maximum shear stress is limited to 70 MN/m^2. Take mod. of rigidity $G = 90\ GN/m^2$.

2008–2009 (Sem. I) (EME102)

1. Calculate the minimum diameter of a solid steel shaft which is not allowed to twist more than 3° in a 6 m length when subjected to a torque of 12 kN-m. Also calculate the maximum shearing stress developed. Take $G = 83$ GPa.

2008–2009 (Sem. II) (EME202)

1. State the assumptions made in the theory of pure torsion.
2. In a tensile test, a test piece 25 mm in diameter, 200 mm gauge length stretched 0.0975 mm under a pull of 50,000 N. In a torsion test, the same rod twisted 0.025 radian over a length of 200 mm, when a torque of 400 Nm was applied. Evaluate the Poisson's ratio and the three elastic modulus for the material.

2009–2010 (Sem. I) (EME102)

1. Prove that shear stress due to pure torsion is directly proportional to the radius of the shaft. The average torque transmitted by a shaft is 2255 Nm. The maximum torque is 146% of average torque. If the allowable shear stress in the shaft material is 45 N/mm^2, determine the suitable diameter of the shaft.

2009–2010 (Sem. I) (TME101) [COP]

1. Calculate the minimum diameter of a solid steel shaft which is not allowed to twist more than 3° in a 6 m length when subjected to a torque of 12 kN-m. Also calculate the maximum shearing stress developed. Take $G = 83$ GPa.

2009–2010 (Sem. II) (EME202)

1. A solid shaft is subjected to a maximum torque of 15 MN-cm. Determine the diameter of the shaft, if the allowable shear stress and the twist are limited to 1 kN/cm^2 and 1°, respectively for 210 cm length of shaft. $G = 8\ MN/cm^2$.
2. Derive the torsion formula $\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$.

2009–2010 (Sem. II) (TME201) [COP]

1. Calculate the minimum diameter of a solid steel shaft which is not allowed to twist more than 3° in a 6m length when subjected to a torque of 12 kN-m. Also calculate the maximum shearing stress developed. Take $C = 83$ CPa.

2010–2011 (Sem. I) (EME102)

1. Determine the suitable values for inside and outside diameters of hollow steel shaft whose internal diameter is 0.6 times its external diameter. The shaft transmits 220 kW at 200 rpm. The allowable shear stress is limited to 75 MPa, and angle of twist is limited to 1° per meter. The modulus of rigidity for shaft material is 80 kN/mm^2.

2. For torsion of a circular shaft, derive the torsion equation. State all the assumptions at the beginning.

2010–2011 (Sem. I) (TME101) [COP]

1. Derive the following expression for the shear stresses developed within a shaft subjected to torsional loading:

$$\tau = \frac{Tr}{J}.$$

2010–2011 (Sem. II) (EME202)

1. A hollow shaft having outer diameter 1.2 times inner diameter is to replace a solid shaft transmitting the same power at the same speed. Determine the outer and inner diameters of the hollow shaft in terms of the diameter of solid shaft and percentage saving in the material (by using hollow shaft). Assume that the same material is used in both the cases.

2010–2011 (Sem. II) (EME202) (MTU)

1. State the assumptions made in the theory of pure torsional. Derive the torsion formula:

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}.$$

2010–2011 (Sem. II) (TME201) [COP]

1. A shaft has to transmit 100 kW at 200 rpm. If the shear a stress is not to exceed 65 N/mm^2, and the twist in a length of 3.50 meter must not exceed 1°. Find a suitable diameter. Take $C = 8 \times 10^4$ N/mm^2.

2011–2012 (Sem. I) (EME102)

1. A solid shaft of diameter 300 mm is proposed to be replaced by a hollow shaft of internal diameter equal to 0.7 times the external diameter. Determine the external diameter of hollow shaft, if the same power is transmitted at the same level of stress.

2011–2012 (Sem. I) (EME102) (MTU)

1. What is pure torsion? Explain the difference between torsional stiffness and torsional rigidity.

2. Calculate the maximum stress induced in a cast iron pipe of external diameter 40 cm and internal diameter 20 cm and of length 4 m when the pipe is supported at its ends and carries a point load of 80 N at its centre.

3. State the assumptions made in the theory of pure torsion. Derive the torsion formula :

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}.$$

2011–2012 (Sem. II) (EME202/EME102)

1. At what location the induced shear stress will be maximum if a circular shaft is exposed to a torque and why?
2. A shaft of hollow circular section has outer diameter 120 mm, Inner diameter 100 mm. Permissible shear stress is 95 MPa. Angle of twist is not to exceed 3.6º in a length of 3 m. The maximum value of torque may exceeds the mean by 30%. Speed of shaft is 2 rps. Determine the maximum value of Power that can be transmitted. Modulus of rigidity = 80 GPa.

2011–2012 (Sem. II) (EME202) (MTU)

1. Differentiate between torsional rigidity and torsional stiffness.
2. Define the Torsion formula. Also indicate the various assumptions mode in torsion theory.
3. Determine the diameter of solid shaft which will transmit 450 kW at 300 rpm. The angle of twist must not exceed one degree per metre length and maximum torsional shear stress is to be limited to 40 N/mm^2. Assume G = 80 kN/mm^2.

2012–2013 (Sem. I) (EME102)

1. A circular shaft of 100 mm diameter transmits a power of 70 kW at 150 rpm. Find the value of maximum shear stress in the shaft and angle of twist per meter. Modulus of rigidity of the shaft material is 60 GPa.

2012–2013 (Sem. I) (EME102) (MTU) [COP]

1. State the assumptions made in theory of pure torsion.
2. State the assumptions made in the theory of pure torsion. Derive the torsion formula:

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}.$$

2012–2013 (Sem. I) (TME101) [COP]

1. A hollow shaft of diameter ratio 3/8 is required to transmit 600 kW at 110 rpm, maximum torque being 20% greater than the mean. The shear stress is not to exceed 63 MN/m^2 and twist in a length of 3 m not to exceed 1.4º. Calculate the maximum external diameter satisfying these conditions.

2012–2013 (Sem. II) (TME201) [COP]

1. Derive the Torsion equation $T/J = \tau/r = G\theta/l$ stating the assumptions made.
2. 20 kN-m torque is applied to a shaft of 7 cm diameter. Calculate the maximum shear stress in the shaft. What will be the shear stress at the central axis of the shaft?

2013–14 (Sem. I) (NME102)

1. Find the polar moment of inertia of a circular area of diameter 5 mm.
2. A hollow shaft of diameter ratio 3 : 5 is required to transmit 800 kW at 200 rpm, the maximum torque being 25% more than the mean torque. If the allowable shear

stress is not to exceed 58 MPa, calculate the internal and external diameters of the shaft.

2013–14 (Sem. I) (EME102/EME202) [COP]

1. List the assumptions made in Torsion theory.
2. Determine the torsional section modulus of a solid circular rod of radius 50 mm.
3. Determine the expression for the shear stress in a hollow cylinder shaft of inner diameter d_i and outer diameter of d_o. Take ratio between d_i to d_o as K.
4. Determine the diameter of solid shaft which will transmit 450 kW at 300 rpm. The angle of twist must not exceed 1° per meter length and maximum torsional shear stress is to be limited to 40 N/mm^2. Assume modulus of rigidity C = 80 kN/mm^2.

2013–14 (Sem. I) (TME101) [COP]

1. A solid circular shaft transmits 75 kW power at 200 rpm. Calculate the shaft diameter, if the twist in the shaft is not to exceed 1° in 2 m length and the shear strength is limited to 50 MN/m^2. Take G = 100 GN /m^2.

2013–14 (Sem. II) (NME202)

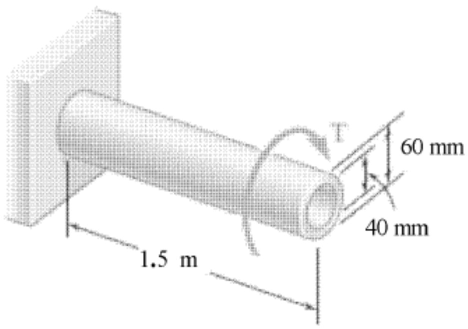
1. A load of 320 kN is applied axially to a hollow tube of 80 mm internal diameter. Determine external diameter if the stress is limited to 125 N/mm^2.
2. A hollow steel shaft of diameter ratio 0.5 is required to transmit a torque of 40 kN.m. The shear stress is not to exceed 50 MPa and angle of twist in a length of 2 m is limited to 1.2°. Calculate the external and internal diameters of the shaft that satisfy these conditions. Take G = 84 GPa.

2013–14 (Sem. II) (EME202) [COP]

1. Find the polar modulus of a circular shaft of diameter 20 mm.
2. A hollow shaft having outside diameter 1.5 times inner diameter is to replace a solid shaft transmitting the same power at the same speed. Determine the outer and inner diameters of the hollow shaft and percentage saving in material (by using hollow shaft). Assume that the same material is used in both the cases.

2014–15 (Sem. I) (NME102)

1. A hollow cylindrical steel shaft is 1.5 m long and has inner and outer diameters respectively equal to 40 and 60 mm (Fig.). (a) What is the largest torque that can be applied to the shaft if the shearing stress is not to exceed 120 MPa? (b) What is the corresponding minimum value of the shearing stress in the shaft?



2014–15 (Sem. I) (EME102) [COP]

1. Define "Torsion".

2014–15 (Sem. II) (NME202)

1. How is shear stress developed due to torsion? Explain.
2. A torque of 1 kN-m is applied to a 40 mm diameter rod of 3 m length. Determine the maximum shearing stress induced and twist produced. Take G = 80 GPa.

2014–15 (Sem. II) (EME202) [COP]

1. A solid steel shaft A of 45 mm diameter rotates at 500 RPM. Find the greatest power that can be transmitted for a limiting shearing stress of 45 MPa in the steel.
2. A shaft of hollow circular section has outer diameter 120 mm, Inner diameter 100 mm. Permissible shear stress is 95 MPa. Angle of twist is not to exceed 3.6° in a length of 3 m. The maximum value of torque may exceeds the mean by 30%. Speed of shaft is 2 rps. Determine the maximum value of Power that can be transmitted. Modulus of rigidity = 80 GPa.

2014–15 (Sem. I) (NME202/NME102/EME202/EME102) [SCOP]

1. Define a shaft & torsional rigidity.
2. Calculate the suitable diameter for a solid circular shaft to transmit 60 kW power at 200 rpm, if the twist is not to exceed 2° in 3 m length of the shaft and maximum shear is limited to 70 MN/m^2. Take shear modulus G = 90GPa.

2015–16 (Sem. I) (NME102)

1. Determine the safe diameter of solid shaft which will transmit 450 kW at 300 rpm. The angle of twist must not exceed 1° per metre length and the maximum torsional shear stress is limited to 40 N/mm^2. Assume modulus of rigidity to be 80 N/mm^2.

2015–16 (Sem. II) (NME202)

1. What are the assumptions taken during derivation of torsion equation. Derive torsion equation $T/J = \tau/r = G\theta/l$.
2. Calculate the minimum diameter of a solid circular shaft which is not allowed to twist more than 2° in a 5 m length when subjected to a torque of 12 kN-m. Also calculate the maximum sharing stress developed. Take modulus of rigidity (G) = 83 GPa.

2015–16 (Sem. II) (EME202) [COP]

1. What do you meant by pure torsion? Write down the assumption taken during torsion.
2. Determine the suitable values of inside and outside diameters of hollow steel shaft whose internal diameter is 0.6 times external diameter. The shaft transmits 220 kW at 200 rpm. The allowable shear stress is limited 45 MPa. The modulus of rigidity for shaft material is 80 kN/mm^2. The angle of twist is 1° per meter.

2017–18 (Sem. I) (RME101)

1. A solid circular shaft transmits 75 kW power at 180 rpm. Calculate the shaft diameter if the twist in the shaft is not to exceed 1 degree in 2 m length and shear stress is limited to 50 MN/m^2. Take modules of rigidity G = 100 GN/m^2.

2017–18 (Sem. I) (NME102/EME102) [COP]

1. A steel propeller shaft transmitting 450 KW at 300 rpm without exceeding a shearing stress of 40 N/mm^2 or twisting through more than 1° per meter. Compute the proper diameter if G = 80 kN/mm^2.

2017–18 (Sem. II) (EME202) [COP]

1. What percentage saving in weight would be obtained if a solid circular shaft is to be replaced by a hollow shaft whose inside diameter is 0.7 times the outside diameter; with the same length, material and maximum permissible shear stress? The solid shaft transmits 300 kW at 100 rpm and shear stress does not exceed 100 MPa.

2017–18 (Sem. II) (ME201) [COP]

1. Define pure torsion and torsional rigidity.
2. Derive the Torsion equation state the assumption made while deriving the bending equation.
3. Compare the weight, strength and stiffness of a hollow shaft of the same external diameter as that of solid shaft .The inside diameter of the hollow shaft being the half the external diameter. Both the shaft have the same material and length.

2018–19 (Sem. I) (NME102/EME102) [COP]

1. Define section modulus and polar modulus.
2. Calculate the minimum diameter of a solid steel shaft which is not allowed to twist not more than 30 in a 6 m length when subjected to a torque of 12 kNm. Also calculate the maximum shearing stress developed. G = 83 GPa.