Shaft:

A shaft is a rotating or stationary member, usually of circular cross-section, having mounted upon it such elements as gears, pulleys, flywheels, cranks, sprockets and other power-transmitting elements. The shafts are relatively long and may be subjected to bending, tension, compression or torsional loads, acting singly or in combination with one another. When they are combined, one may expect to find both static and fatigue strengths to be important design consideration, since a single shaft may be subjected to static stresses, completely reversed stresses and repeated stresses, all acting at the same time.

a) Transmission shaft – It is used to transmit power between the power source and the machines absorbing power. It is generally subjected to torque, bending moment and axial load in combination e.g. line shaft, counter shaft, head shaft and all factory shafts.
b) Machine shaft – It is integral part of a machine. It is used to transfer motion and power within the machine e.g. crank shaft, gear shaft.
c) Axle – It is a stationary or rotating shaft. It does not carry any torsional load. It is subjected to bending moment due to transverse load only. It is used to support rotating parts e.g. axles of automobiles.
d) Spindle – It is a short rotating shafts used to impart motion either to cutting tool or work piece e.g. lathe spindle, drill press spindle.

Materials: Commonly adopted materials are mild steel. In addition, different types of alloy steels are also used for shafts, depending on situation and types of application.

Deflection restraints: $\delta = L/1200$, where δ and L are maximum transverse deflection of the shaft and length of shaft between bearing supports respectively.

Twist restraint: Maximum twist is 2.5-3.5 degree per meter of shaft length for line shaft. It is with 0.25 degree per meter of machine shaft.

Problem:

A solid horizontal steel shaft is to run in self-aligning bearings A and B, 2500mm apart. The shaft is driven from the right of right-hand bearing with an electric motor. The power is supplied to a machine from the shaft through a 500-mm diameter pulley, mounted on the shaft with a rectangular key at 1200mm from the left-hand bearing. The belt tensions are 1800N and 840N and they are parallel to each other and at 64^{O} to the horizontal. The weight of the pulley is 500N. Determine the diameter of the shaft.
Use the following data:
Material = FeE 200; Factor of safety = 2.5;
Combined shock and fatigue factor for bending = 1.6;
Combined shock and fatigue factor for torsion = 1.2;
Allowable tensile stress for key material = 120MPa