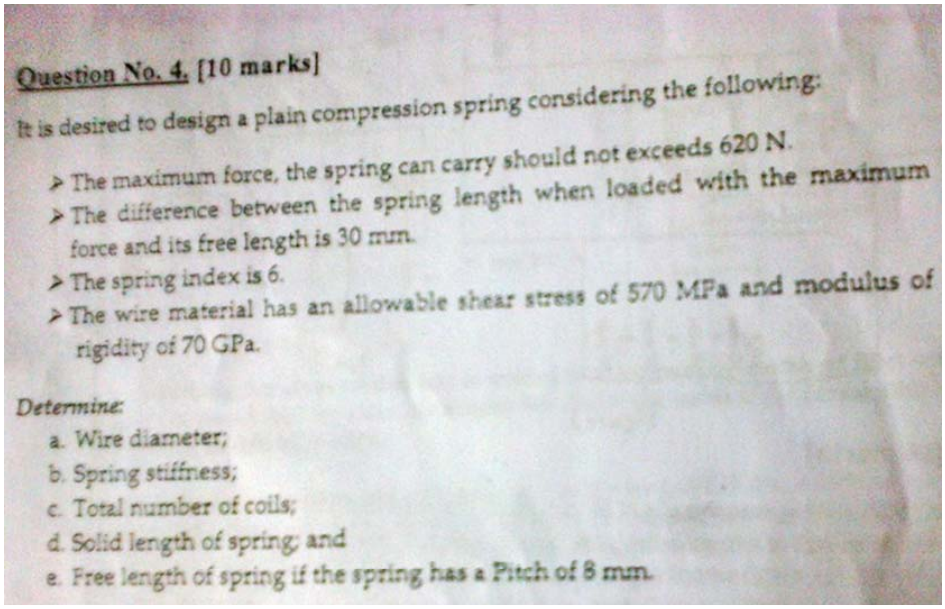

Question No. 4. [10 marks]

It is desired to design a plain compression spring considering the following:

- The maximum force, the spring can carry should not exceeds 620 N.
- The difference between the spring length when loaded with the maximum force and its free length is 30 mm.
- The spring index is 6.
- The wire material has an allowable shear stress of 570 MPa and modulus of rigidity of 70 GPa.

Determine:

a. Wire diameter;
b. Spring stiffness;
c. Total number of coils;
d. Solid length of spring; and
e. Free length of spring if the spring has a Pitch of 8 mm.

$F_{\max} = 620N$, $\delta_{\max} = 30mm$, $c = \frac{D}{d} = 6$, $D = 6d$, $\tau_{all} = 570MPa$, $G = 70GPa$

Solution

a) Wire diameter d = ??

$$K = \frac{4c-1}{4c-4} + \frac{0.615}{c} = \frac{4x6-1}{4x6-4} + \frac{0.615}{6} = 1.25$$

$$\tau = K\frac{8FD}{\pi d^3} = K\frac{8Fc}{\pi d^2}\ ,\ \tau_{all} = K\frac{8F_{\max}c}{\pi d^2}$$

$$570 = 1.25x\frac{8x620x6}{3.14xd^2}\ ,\ d = 4.6mm$$

b) Spring stiffness k = ??

$$F = k\delta\ ,\ k = \frac{F}{\delta} = \frac{F_{\max}}{\delta_{\max}} = \frac{620}{30} = 20.667N/mm$$

c) Total number of coils N+2 = ??

$$\delta = \frac{8FD^3N}{Gd^4}\ ,\ \delta_{\max} = \frac{8F_{\max}D^3N}{Gd^4}\ ,\ 30 = \frac{8x620x6^3xd^3xN}{70x10^3xd^4}\ ,\ N = 9.02 \approx 10\ turn$$

Total number of coils = 10 + 2 = 12 turns

d) Solid length of spring = ??

$$solid\_length = (N+1)d = (12+1)4.6 = 59.8mm$$

e) Free length of spring = ?? if P = 8 mm

$$Free\_length = (PxN) + d = (8x12) + 4.6 = 100.6mm$$