Question 1

Derive the force equations for F, N, F_s, and F_n as functions of cutting and thrust forces using Merchant's circle.

Question 2

A 200 mm long, 75 mm diameter titanium alloy rod is being reduced in diameter to 6.5 mm by turning on a lathe. The spindle rotates at 400 rpm, and the tool is traveling at an axial velocity of 250 mm/min. Calculate the cutting speed, material removal rate, time of cut, power required and cutting force. (hint: the specific energy of titanium ranges from 3.0 to 4.1 W.s/mm^3)

Question 3

In a surface grinding operation performed on hardened plain carbon steel, the grinding wheel has a diameter = 200 mm and width = 25 mm. The wheel rotates at 2400 rev/min, with a depth of cut (in-feed) = 0.05 mm/pass and a cross-feed = 3.50 mm. The reciprocating speed of the work is 6 m/min, and the operation is performed dry. Determine: (a) the length of contact between the wheel and the work, (b) the volume rate of metal removed. (c) If C = 0.64 active grits/mm^2, estimate the number of chips formed per unit time. (d) What is the average volume per chip? (e) If the tangential cutting force on the work = 30 N, compute the specific energy in this operation?

Question 4

A slab-milling operation is being carried out on a 30 in. long, 6 in. wide high strength steel block at a feed of 0.01 in./tooth and a depth of cut of 0.15 in. The cutter has a diameter of 3 in. has eight straight cutting teeth, and rotates at 150 rpm. Calculate the material removal rate and the cutting time, and estimate the power required.

Question 5:

An orthogonal cutting operation is being carried out under the following conditions: depth of cut = 0.15 mm, width of cut = 5 mm, chip thickness = 0.2 mm, cutting speed = 2 m/s, rake angle = 15°, cutting force = 500 N, and thrust force = 200 N. Calculate the percentage of the total energy that is dissipated in the shear plane during cutting.

Question 6:

i) A series of turning tests are performed to determine the parameters n, m, and K in the expanded version of the Taylor's equation. The following data were obtained during the tests: (1) v = 2.0 m/s, f = 0.20 mm/rev, T = 12 min; (2) v = 1.5 m/s, f = 0.20 mm/rev, T = 40 min; and (3) v = 2.0 m/s, f = 0.3 mm/rev, T = 10 min. (a) Determine n, m, and K. (b) Using your equation, compute the tool life when v = 1.5 m/s and f = 0.3 mm/rev.

ii) Using the Taylor equation for tool wear and letting n = 0.4, calculate the percentage increase in tool life if the cutting speed is reduced by (a) 20% and (b) 50%.

Question 7:

A gun-drilling operation is used to drill a 7/16-in diameter hole to a certain depth. It takes 4.5 minutes to perform the drilling operation using high pressure fluid delivery of coolant to the drill point. The cutting conditions are: N = 3000 rev/min at a feed = 0.002 in/rev. In order to improve the surface finish in the hole, it has been decided to increase the speed by 20% and decrease the feed by 25%. How long will it take to perform the operation at the new cutting conditions?