**Department of Mechanical Engineering**
**Indian Institute of Technology Kharagpur**

**Mid-Semester Examination of Machine Tools and Machining (ME30604)**

Number of Students: 231 Full Marks: 60 Duration: 2 hours

3rd Year BTech and Dual Degree Students of ME, MF, IEM and QEDM

**All symbols have usual interpretations**
**Attempt all questions**

1 a) The cross feed lead screw of a centre lathe rotates at 5 rpm during facing operation. The pitch of the cross feed lead screw is 5 mm. The spindle speed is 500 rpm. Calculate the cross feed in mm/rev. 2

OR

Sketch a speed reversing mechanism using bevel gears and clutch.

b) An input shaft is connected to the output shaft by a pair of gears. The numbers of teeth of the gear on the input and output shafts are 30 and 60, respectively. Determine the transmission ratio when an idler with 40 teeth is introduced between the input and output gear. 2

OR

Show that the minimum difference between number of teeth of adjacent gears of a sliding cluster is 4

c) A low carbon steel bar of 100 mm diameter is being turned at a cutting speed of 110 m/min. The feed is 0.24 mm/rev. Determine the rotational speed of the pinion which is in mesh with the rack on the underside of the lathe bed. The pinion has 16 number of teeth and the rack has module of 1.5. 2

d) One input shaft is connected to an output shaft by a pair of cluster gears. Each cluster has 2 gears. The cluster on the input shaft has gears with 30 and 40 teeth. The gear on the output shaft that meshes with the gear (having 40 teeth on the input shaft) also has 40 teeth. Determine the minimum transmission ratio between the input and output shaft. Modules of all the four gears are the same. 2

e) A lathe is set to work at a longitudinal feed of 0.2 mm/rev. The transmission ratio of the multiplier gear train mounted on quadrant bracket of the lathe (i.e. change gear quadrant) happens to be 1:1. Now the feed is to be modified to 0.01 inch/rev by only changing transmission ratio of the multiplier. Determine number of teeth of driving and driven gear of the multiplier. 4

OR (either attempt (e) or (f) and (g))

f) The lead screw (which is used for thread cutting) of a centre lathe is rotating at 50 rpm during thread cutting. The pitch of the lead screw is 10 mm. The rotational speed of the main spindle is 250 rpm. Determine the pitch of thread being cut. 2

g) The headstock of a centre lathe receives power from a floor mounted motor. The motor is 2

connected to the headstock by a belt and pulley mechanism. The diameter of the pulley on the motor spindle is 300 mm and the diameter of the pulley on the headstock is 200 mm. The input shaft of the headstock rotates at 2160 rpm. Determine the rotational speed of the motor.

2 a) For a single point turning tool, the angle between the cutting plane and the auxiliary cutting plane is 90° as measured on the reference plane. The orthogonal rake is −10°. Determine the inclination angle of the auxiliary cutting edge. 4

b) For a right-handed single point turning tool the principal and auxiliary cutting edge angles are 75° and 15°, respectively. The absolute value of the angle between the rake surface and the reference plane as measured on the auxiliary cutting plane is 10°. The master line of the rake surface appears on the left hand side of the principal cutting edge and is parallel to the principal cutting edge (when the top view of the cutting tool is drawn on the reference plane). (i) Determine the orthogonal rake angle and inclination angle of the principal cutting edge, and (ii) draw the top view of the cutting tool on the reference plane showing the position of masterline. 6

c) Under which geometrical conditions orthogonal rake, side rake and maximum rake of a single point turning are equal? 2

3 The transmission ratio of the headstock of a centre lathe is $1/16$. The input shaft of the headstock rotates at 2880 rpm. The transmission ratios of the change gear quadrant (multiplier), Norton-Tumbler mechanism and the Meander mechanism are $1/4$, 1 and 1. The apron constant is 100. The pinion responsible for longitudinal feed of the apron box (which is in mesh with the rack on the underside of the lathe bed) has 16 teeth and a module of 1.5. (i) Determine the longitudinal feed in mm/rev and feed rate in mm/min. (ii) Now the main motor is changed and thus the input shaft of the headstock now rotates at 1440 rpm. Under this circumstances, determine the longitudinal feed rate in mm/min. 12

4 Exhibit the generatix and directrix and write the generatrix and directrix statements for the following operations (i) end milling, (ii) gear shaping, (iii) gear milling, (iv) thread cutting in lathe 12

5 a) For a single point right handed HSS turning tool, the orthogonal rake and side rake are the same and they are equal to $+10^0$ (in Tool-In-Hand system). An alloy steel bar of 80 mm diameter is being turned at a cutting velocity of 20 m/min and at a given feed. The longitudinal feed velocity is 20 mm/min. Find out feed in mm/rev. Determine principal cutting edge angle. Find out the value of the orthogonal rake in work reference system (WRS) i.e. Tool-In-Use system. If the orthogonal clearance in WRS i.e. Tool-In-Use system is $+5^0$, then determine the orthogonal clearance of the tool in ORS or Tool-In-Hand system. 8

b) Draw the sectional view of a single point turning tool to depict maximum rake angle clearly indicating the location of master line. Also show the direction along which the rake angle is zero. 4

$\frac{20\ m}{60\ s} = \pi \times 0.08 \times N$

$N = 1.326$ rps

$0.02\ m = 3.33 \times 10^{-9}\ \frac{m}{s}$

1s — 1.326 r

$V_c = \pi D N$

$u_m = SN$