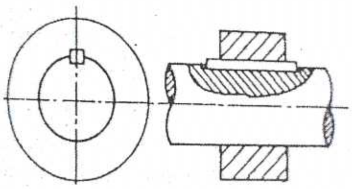
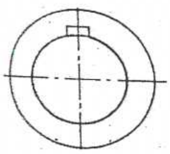
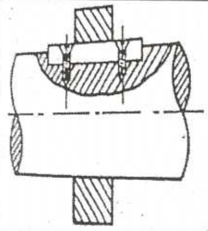
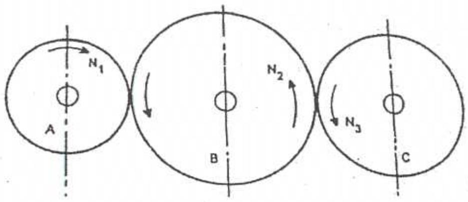
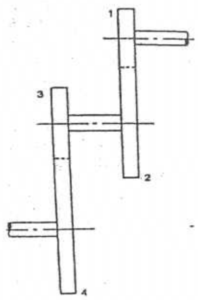
9 Set-2 1

Scoring Indicators

Code: 5021 (18) **Version: B**

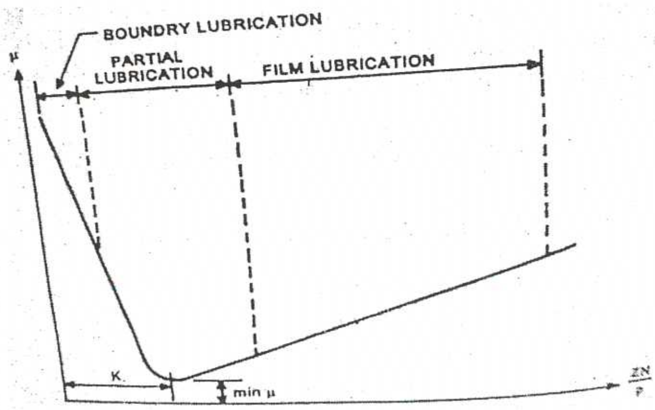
Qn. No.	Scoring indicators	Split score	Total Score
	Part – A		
I 1	Load, Mechanism, Material, Manufacturing process, Cost, safety (any4)	2	
2	Torque $T = (\pi/16) \times d^3 \times \tau$ Where d = Diameter of shaft τ = Permissible shear stress	2	
3	Coefficient of fluctuation of speed is the ratio of max. fluctuation of speed to the mean speed. $K_s = (\omega_1 - \omega_2) / \omega$	2	
4	The relative motion b/w belt and pulley is called slip. Expressed in %.	2	
5	The distance b/w corresponding points of adjacent teeth measured along pitch circle.	2	10
	Part – B (Any Five)		
II 1	Efficiency of screw jack is the ratio of Ideal torque to the actual torque. $\eta = (W \times r \times \tan\alpha) / W \times r \times \tan(\alpha + \phi)$ $\eta = \tan\alpha / \tan(\alpha + \phi)$ (independent of Load)	3 +3	6
2	 Sunk key Half portion on shaft and half portion on hub. Capable to take high loads..Key way expensive.  Saddle Key Key way is provided only in hub...Suitable for small loads. Keyway cutting is cheap.	Fig 4 + 2	6

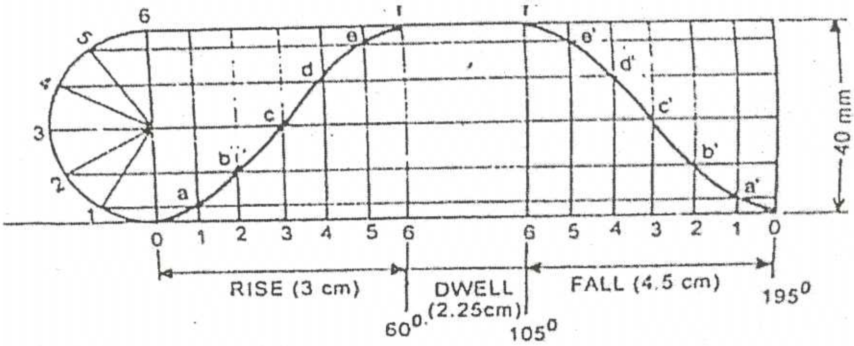
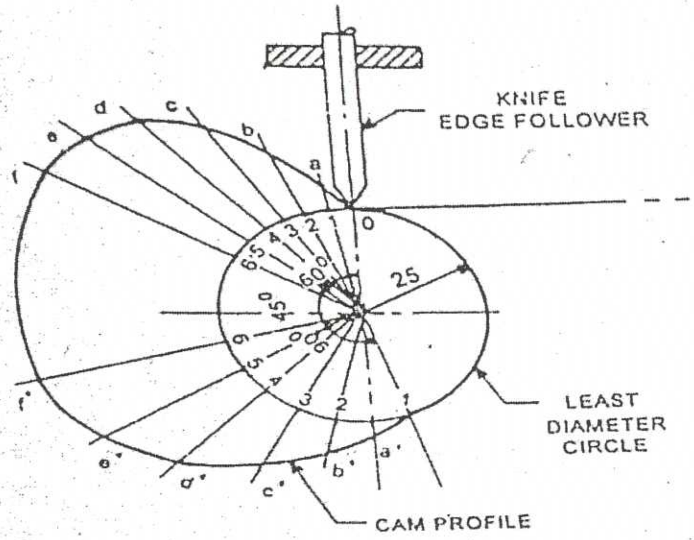
	 Axial movement of hub is permitted...Clutches..change gears Feather Key		
3	Torque T = 20 kN –m = 20 x 10^6 N–mm. Permissible shear stress (τ) = 70 N/mm^2. Torque T = (π/16) x d^3 x τ 20 x 10^6 = (π/16) x d^3 x 70 Diameter of shaft d = 113.3 mm ....**(Ans.)**	3 + 3	6
4	Torque T = 1365 N-m = 1365 x 10^3 N –mm. τ for muff = 15 N/mm^2. τ for Shaft = 30 N/mm^2. Shaft Torque T = (π/16) x d^3 x τ = 1365 x 10^3 = (π/16) x d^3 x30 Diameter of shaft d = 61.42 mm = 62 mm .... **(Ans.)** Muff Muff inner Dia = d = 62 mm. Muff Outer dia = 2d + 13 mm = 137 mm.......... **(Ans.)** Check T = (π/16) x D^3 x τ (1- K^4) = (π/16) x 137^3 x τ (1- $(62/137)^4$) τ = 2.8 N/mm^2 ... (safe)	2 + 2 + 2	6
5	According to load application 1.Radial Bearing (Journal Bearing) Load Perpendicular to axis (Bushed Bearing, Plummer Block etc) 2. Thrust Bearing Load parallel to axis (Ex; Foot step, Collar Bearings) 3.Guide Bearing Guide the motion of Machine member. According to the type of contact 1. Sliding contact Bearing (Ex. Bushed Bearing) 2. Rolling contact Bearing (Ex: Ball Bearing, Roller Bearing)	3 + 3	6
6	i) Height of governor :-The vertical distance from centre of ball to the point where axis of arms intersects on the spindle axis.	2	

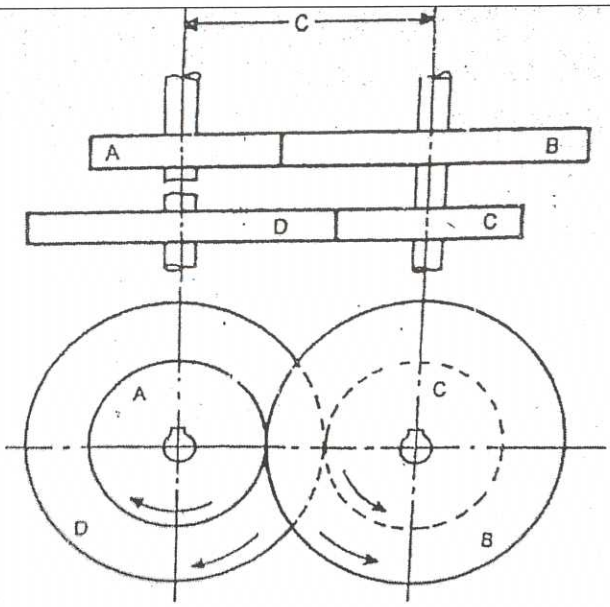
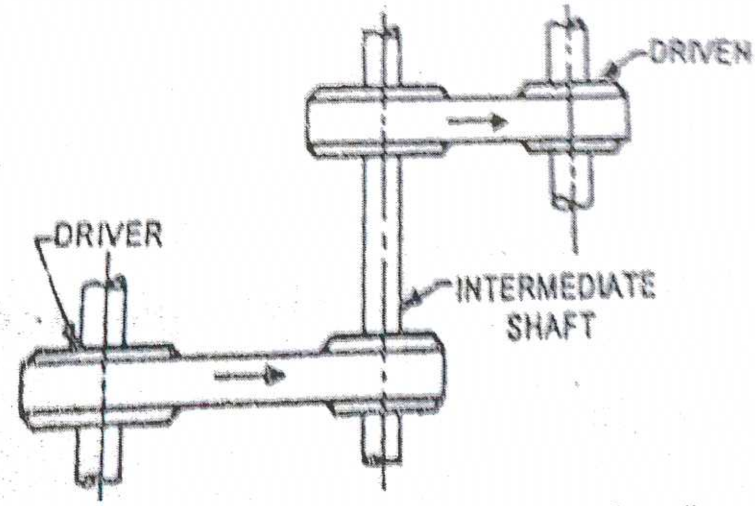
	ii) <u>Isochronism of Governor :-</u> The prime mover runs at a particular speed for any position of sleeve. iii)<u>Hunting of Governor</u> :- Speed of prime mover controlled by the governor fluctuates continuously above and below the mean speed .	+ 2 + 2	6
7	 Velocity ratio= N3/N1 = Z1/Z3 <u>Simple Gear Train</u>  V.R. = N2/N1 x N4/N3 = Z1/Z2 x Z3/Z4 <u>Compound Gear Train</u>	3+3	6
	Part – C UNIT – 1		
III (a)	Weight W = 25 kN. = 25 x 10^3 N Ultimate tensile strength σu = 480 N/mm^2 Factor of safety = 6 Permissible stress $\sigma t = 480/6 = 80$ N/mm^2 $\sigma t = W/(\pi/4) \times d^2. = 80 = 25 \times 10^3 /(\pi/4) \times d^2$ Diameter of bolt = 19.95 mm ....**(Ans.)**	2 + 3 + 2	7
(b)	W = 2500 N , Mean Dia d = 75 mm. , Pitch = 12 mm , $\mu = 0.075$ $\tan \alpha$ = Pitch / π d = 12 / (π d x 75) $\alpha = 2.919^0$ $\mu = \tan \phi$, $\phi = \tan^{-1} 0.075 = 4.289^0$. Efficiency = $\tan \alpha / (\tan(\phi + \alpha))$ = tan 2.919 / (tan (4.289 + 2.919)) = 0.403 = 40.3 5 .... **(Ans.)**	2 + 2 + 4	8

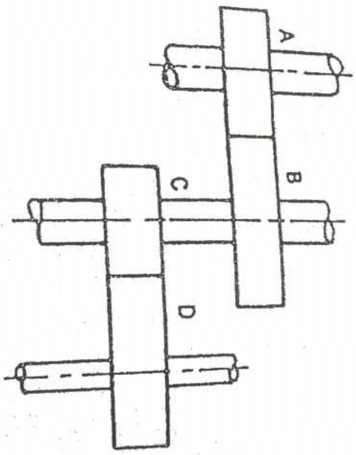
	OR		
IV (a)	d = 40 mm. , F = 20 x 1000 N , τ = 60 N/mm^2		
	Width of Key W = d/4 = 40/4 = 10 mm. ……………………….**(Ans.)**	2	
	Height of Key H = d/6 = 40/6 = 6.67 mm = 8 mm…………….**(Ans.)**	+	7
	Force F = w x L x τ = 20000 = 10 x L x 60	2+	
	Length of Key L = 34 mm……………………………….**(Ans.)**	3	
(b)	Max. Pressure = 1 N/mm^2 , Back Pressure = 0.015 N/ mm^2		
	D = 300 mm. , σ t = 45 N/ mm^2.	2	
	Effective Pressure = (1 - 0.015) N/ mm^2 = 0.985 N/ mm^2.	+	
	Tensile load on piston rod P = Pressure x (π/4) D^2. = 0.985 x (π/4) 300^2	2	
		+	
	P = 69590.25 N	2	
	Also P = (π/4) d_c^2 x σ t	+	
	69590.25 = (π/4) d_c^2 x 45		
	d_c = 44.4 mm	2	8
	Nominal Diameter d = 44.4/ 0.84		
	d = 52.84 = 53 mm ……………………………….**(Ans.)**		
	UNIT – 2		
V (a)	Power = 1.25 x 10^6 Watts , N = 240 RPM. , τ = 75 N/ mm^2		
	Power = 2 π N T / 60 = 2 π x 240 T / 60		
	Torque T = 49735.9 Nm = 49735.9 x 10^3 N mm	2	
	But T = (π/16) x d^3 x τ = 49735.9 x 10^3 = (π/16) x d^3 x 75		
		+	
	Dia. Of shaft d = 150 mm ………………………… **(Ans.)**		
	Pitch circle Diameter D_p = 1.5 x 150 = 225 mm.	2	
		+	
	T = (π/4) d^2 x n x τ x (D_p / 2)		
	49735.9 x 10^3 = (π/4) d^2 x 6 x 100 x (225 / 2)		7
	Bolt Dia d = 30.6	3	
	Nominal Dia. = 30.6/0.84 = 36.4 = M38 Bolt ………………**(Ans.)**		
(b)	Torque T = 30 x 10^6 N mm. , τ = 100 N/mm^2.		
	Θ = 1^0 = π / 180 rad = 0.0175 rad L = 1000 mm	2	

	$G = 80 \times 10^3\ N/mm^2$.		8
	$J = \pi d^4 / 32 = 0.098\ d^4$	2	
	$T / J = G \theta / L$; $30 \times 10^6 / 0.098\ d^4 = (80 \times 10^3 \times 0.0175) / 1000$	4	
	Dia. Of Shaft d =121.6 mm ....**(Ans.)**		
	OR		
VI (a)	$n = 8$, PCD = 120 mm , $T = 2500\ N\ m = 2500 \times 10^3\ N\ mm$		
	$\tau = 70\ N/mm^2$.		
	$T = (\pi/4)\ d^2 \times n \times \tau\ (D_p /2)$	2	
		+	
	$2500 \times 10^3 = (\pi/4)\ d^2 \times 8 \times 70\ (120 /2)$		7
		2	
	Root Dia of bolt d = 19.46 mm	+	
	Nominal Dia = 19.46 / 0.84 = 23.16 = M24 Bolt..... **(Ans.)**	3	
b)	Power = 500×10^3 watts , N = 450 RPM , $\tau = 60\ N/mm^2$.		
	K = 0.5 , T max = 1.25 T mean		
	Mean Torque $T = (60 \times 500 \times 10^3) / (2 \times \pi \times 450) = 10615.71$ Nm	2	
		+	
	$T = 10615.71 \times 10^3\ N\ mm$.		
	$T_{max} = 1.25 \times 10615.71 \times 10^3 = 13269639\ N\ mm$	2	
	$T_{max} = (\pi /16)\ D^3\ \tau\ (1 - k^4)$	+	8
	$13269639 = (\pi /16)\ D^3 \times 60\ (1 - 0.5^4)$	2	
	Outer Dia. D = 106.32 mm -------------------------**(Ans.)**	+	
	inner dia. D = 106.32 / 2 = 53.16 mm-------------------------**(Ans.)**	2	
	UNIT – 3		
VII (a)	Max. fluctuation of energy The difference b/w the kinetic energy at max. speed and minimum speed is called Max. fluctuation of energy.	2	

	<u>Coefficient of fluctuation of energy</u> The ratio of max. fluctuation of energy to the net work done per cycle is called coefficient of fluctuation of energy. $K_s = dE/E$	2	7
	<u>Energy stored in flywheel</u> The Kinetic energy stored in a flywheel in a cycle will be equal to the max. fluctuation of energy. Energy stored in flywheel $= ½ \times I \times (\omega_2^2 - \omega_1^2)$.	3	
(b)	Dia of Journal D = 60 mm. , Load $W = 4.5$ kN $= 4.5 \times 10^3$ N N = 180 RPM , $\mu = 0.02$, L/D = 3 Length of Bearing $L = 3 \times D = 3 \times 60 = 180$ mm. Projected Area $A = L \times D = 180 \times 60 = 10800$ mm^2		
	a) Bearing pressure $P_b = W/A = (4.5 \times 10^3) / 10800$ $= 0.416$ N/mm^2 ....**(Ans.)**	2 +	
	Frictional torque $T = \mu \times W \times R = 0.02 \times 4.5 \times 10^3 \times 30$ $= 2700$ N mm $= 2.7$ N m		
	(b) Power lost in friction $= 2 \times \pi N T / 60 = 2 \times \pi \times 180 \times 2.7 / 60$ $= 50.87$ Watts..................**(Ans.)**	3 +	8
	c) Heat generated = Power lost in friction $= 50.87$ Watts..................**(Ans.)**	3	
	OR		
VIII (a)	The term (ZN/P) is called bearing characteristic number. Where Z = Ab. Viscosity N = RPM P= Bearing pressure	3 +	
		4	7

(b)	 	3	
	 	5	8
	UNIT – 4		
IX			
(a)	Effective Dia. d = (270 = 12) = 282 mm. = 0.282 m Belt speed $v = \pi d N / 60 = \pi \times 0.282 \times 300 / 60 = 4.43$ m/s Power $P = (T_1 - T_2) \times v = (1560 - 490) \times 4.43$ Watts P = 4740.1 Watts………………………………………**(Ans.)**	3 + 4	7
(b)	Reverted gear train is a type of compound gear train in which driver and driven gears are mounted on co-axial shat. This reduce the space requirements. Back Gear of Lathe, Automobile gear boxes etc are the examples. Velocity ratio Gear B and C rotate at the same RPM (Compound Gear) So $N_D / N_A = (T_A / T_B) \times (T_C / T_D)$	4	

		4	8
	OR		
X (a)		4	7
	Large velocity ratio can be achieved by arranging the pulleys as compound drive as shown in fig. <u>Velocity Ratio</u> $N4 / N1 = (D1 / D2) \times (D3 / D4)$ $(N2 = N3)$	3	
(b)	Speed of A $N1 = 300$ RPM		

		**2**	
	No.of teeth on A $T_A = 25$, $T_B = 50$ $T_C = 35$ $T_D = 70$ Let N4 be the speed of Wheel D	3	**8**
	Then Velocity Ratio = $N_4 / N_1 = (T_A / T_B) \times (T_C / T_D)$		
	$N_4 = [(25 \times 35) / (50 \times 70)] \times 300 = 75$ RPM ---------------- **(Ans.)**	3	