SCHEME OF VALUATION

(Scoring Indicators)

Revision: DESIGN OF MACHINE ELEMENTS	Course Code: 5021			
Qst.No.	Scoring Indicator	Split Up	Sub total	Total
	PART-A			
I 1)	Pitch – it is the distance from one point on a screw thread to the corresponding point on the adjacent screw thread measured parallel to the axis of the screw	1	2	
	Lead – it is the distance moved by the threaded point parallel to the axis of screw in one complete turn.	1		
2)	$w = d/4$, $t = \frac{2}{3}w = \frac{d}{6}$, $l = 1.5d$ where d = diameter of the shaft in mm w = width of the key in mm t = thickness of height of the key in mm l = length of the key in mm.	2	2	
3.	$\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$	2	2	
4.	If a governor is too sensitive, it may fluctuate continuously above and below the mean speed because when the load on the engine falls or increase. The process is hunting	2	2	
5	1) No slip takes place, hence perfect velocity ratio occurs. 2) More compact than belt drive. 3) It can be used when exact timing in movement is desired. 4) Unaffected by environmental condition 5) it is more durable. 6) No initial tension is required.	2	2	5×2 = 10

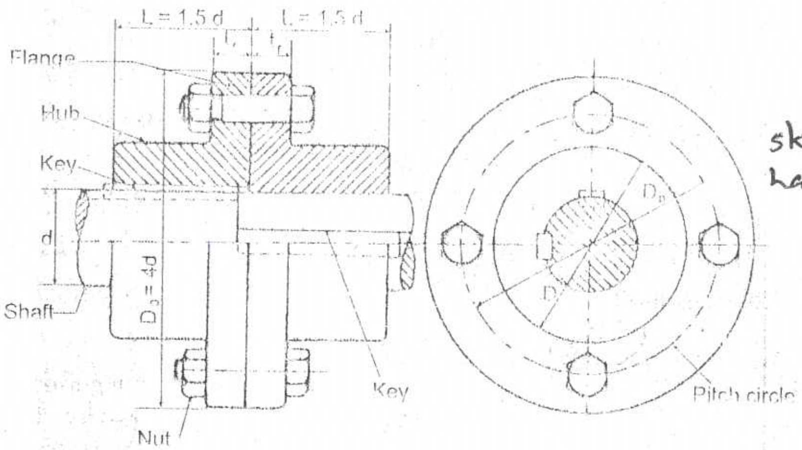
SCHEME OF VALUATION

(Scoring Indicators)

Revision:		Course Code:		
Qst.No.	Scoring Indicator	Split Up	Sub total	Total
	PART- B			
II. 1)	a) Type of load and stresses caused by the load b) Motion of the parts c) selection of material d) Form and size of the parts. e) Frictional resistance and lubrication f) Convenient and economical features g) Use of standard parts h) Safety of operation i) Workshop facility j) Number of machines to be manufactured k) cost of construction l) Assembling m) Durability and reliability n) Effect of environment		6	6
2)	The efficiency of a screw jack = Ideal effort / Actual effort. Effort required to lift the load when considering screw friction } $P = W\tan(\alpha+\phi)$ When neglecting friction, $P_0 = W\tan\alpha$. Then $\eta = \frac{P_0}{P} = \frac{W\tan\alpha}{W\tan(\alpha+\phi)}$ $\eta = \frac{\tan\alpha}{\tan(\alpha+\phi)}$ This equation shows that the efficiency of a screw jack is independent of the load raised.		6	

SCHEME OF VALUATION

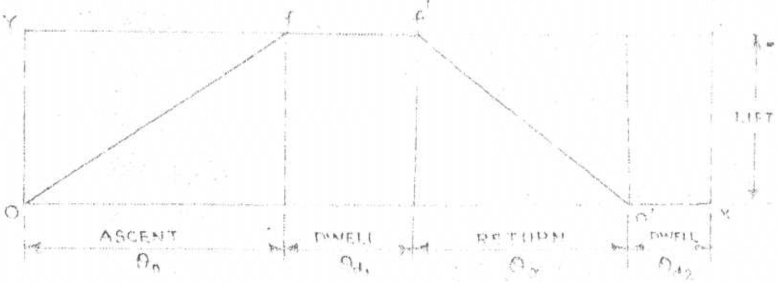
(Scoring Indicators)

Revision:		Course Code:		
Qst.No.	Scoring Indicator	Split Up	Sub total	Total
3)	$d_o = 200\ mm$, $d_i = 150\ mm$ $\tau = 60\ MPa = 60\ N/mm^2$ Diameter ratio, $k = \frac{d_i}{d_o} = \frac{150}{200} = 0.75$ strength of the shaft means the maximum torque that can be transmitted. Then, $T = \frac{\pi}{16} \tau d_o^3 (1-k^4)$ $= \frac{\pi}{16} \times 60 \times 200^3 (1-0.75^4)$ $= 64427193.09\ N\text{-}mm$ $= 64.43\ kN\text{-}m$		6	
4)		sketh-4 Label-2	6	

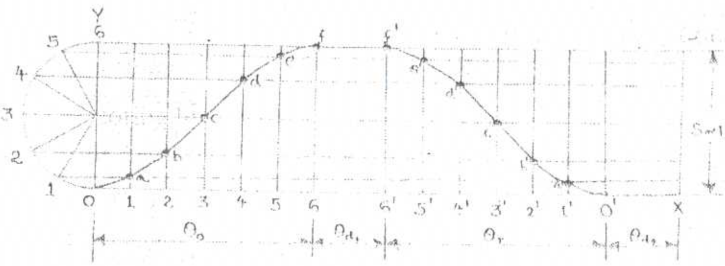
SCHEME OF VALUATION

(Scoring Indicators)

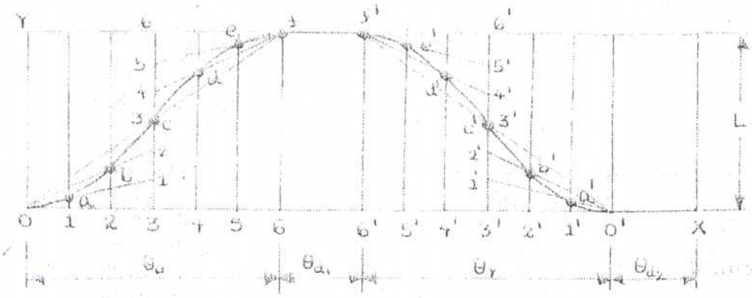
Revision:		Course Code:		
Qst.No.	Scoring Indicator	Split Up	Sub total	Total
5				



.9 Displacement diagram when the follower moves with uniform velocity.



. 7.10 Displacement diagram when the follower moves with SHM



Displacement diagram when the follower moves with uniform acceleration and retardation

		Split Up	Sub total	Total
	Uniform velocity diagram		2	
	SHM diagram		2	6
	Uniform acceleration and retardation diagram		2	

SCHEME OF VALUATION

(Scoring Indicators)

Revision:		Course Code:		
Qst.No.	Scoring Indicator	Split Up	Sub total	Total

6) The turning moment diagram developed by a single cylinder four stroke internal combustion engine for one complete cycle is shown in *Fig 8.6*.

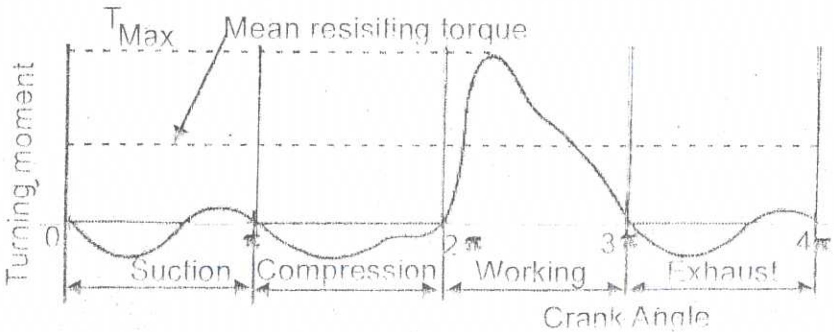


Fig 8.6 Turning moment diagram

Fig-4 } 6
nde-2 }

We know that in a four stroke internal combustion engine, there is only one power stroke after the crank has turned through two revolutions (i.e., 720^0 or 4π radians) or one cycle. Since the product of the turning moment and the angle turned is the work done, therefore, the area of turning moment diagram represents the work done per cycle. If the speed is same after one cycle then work done by the engine is equal to the resistance overcome during this time. The total area of the turning moment diagram will, therefore, be equal to the area of resistance diagram. Generally, resistance is assumed to be constant throughout the cycle. This mean resistance torque is determined by dividing the area of turning moment diagram by the angle turned in one cycle. The mean resistance torque as shown by a horizontal line.

Qst.No.	Scoring Indicator	Split Up	Sub total	Total
7.	Advantages - 1) They give positive drive and constant speed ratio. 2) more compact due to shorter center distance 3) Can be operated at Higher speeds. 4) Used where precise timing is desired 5) wide range of power transmitted 6) Can be used for non intersecting and nonparallel shaft		3	6
	Disadvantages 1) Not suitable for large center distances 2) Requires perfect alignment of shafts. 3) Lubrication is required. 4) Manufacturing of gears is complex. 5) Error in manufacturing of gears causes vibrations and noises.		3	

SCHEME OF VALUATION

(Scoring Indicators)

Revision:		Course Code:		
Qst.No.	**Scoring Indicator**	**Split Up**	**Sub total**	**Total**
	PART – C UNIT – 1			
III a)	Sunk key – Rectangular sunk key – Square sunk key – Parallel sunk key – Gib headed key – Feather key – Woodruff key.	3		
	Saddle key – Hollow saddle key – Flat saddle key	1	7	
	Tangent key	1		
	Round key	1		
	splines.	1		
b)	$D = 0.4\,m$, $P = 1.1\,MPa$, $\sigma_t = 32\,MPa$, $n = 12$			
	The force acting on the cylinder head, $P = \frac{\pi}{4} D^2 p$ $= \frac{\pi}{4} \times (0.4 \times 10^3)^2 \times 1.1$	2		
	Resistance offered by the bolts, $P = \frac{\pi}{4} d_c^2 \sigma_t n$ $= \frac{\pi}{4} \times d_c^2 \times 32 \times 12$	2	8	
	Equating the above two equation $\frac{\pi}{4} d_c^2 \times 32 \times 12 = \frac{\pi}{4} (0.4 \times 10^3)^2 \times 1.1$ $d_c = \sqrt{\frac{(0.4 \times 10^3)^2 \times 1.1}{32 \times 12}} = 21.41\,mm$	2		
	nominal diameter, $d = \frac{d_c}{0.84} = \frac{21.41}{0.84} = 25.49$ say 28 mm	2		

SCHEME OF VALUATION

(Scoring Indicators)

Revision:		Course Code:		
Qst.No.	Scoring Indicator	Split Up	Sub total	Total
IV a)	Types of bolt which are undergoing impact load should be designed not only for strength but also for their ability to absorb impact energy. In an ordinary bolt, the effect of the impulsive load applied axially is concentrated on the weakest part of the bolt. The root of the threaded portion of the bolt is the weakest part. The ideal bolt will be one which is subjected to same stress level at different cross sections in the bolt. It is called the bolt of uniform strength.	4	7	
	method of making uniform strength - a) The diameter of the shank is reduced to the core diameter of the threads. b) The cross sectional area of the shank is reduced to the cross sectional area of the root by an axial hole is drilled through the head.	3		
b)	Mean diameter, $d_m = 40$ mm pitch of screw, $p = 12$ mm $\mu = 0.1$, $W = 20$ kN, $L = 450$ mm			
	Helix angle, $\alpha = \tan^{-1}\left(\frac{np}{\pi d_m}\right)$ $= \tan^{-1}\left(\frac{1 \times 12}{\pi \times 40}\right) = 5.45°$	2		
	Frictional angle $\phi = \tan^{-1}\mu = \tan^{-1}(0.1) = 5.71°$	1		
	Effort required at the mean circumference of the threads to lift the load, $P = W\tan(\alpha+\phi)$ $= 20 \times 10^3 \tan(5.45 + 5.71)$ $= 3945.59$ N	2		

SCHEME OF VALUATION

(Scoring Indicators)

Revision:		Course Code:		
Qst.No.	**Scoring Indicator**	**Split Up**	**Sub total**	**Total**
	using the relation, $T = P'L = P \times \frac{d_m}{2}$. ∴ Effort applied at the end of the lever to lift the load, $P' = \frac{P d_m}{2L}$ $= \frac{3945.59 \times 40}{2 \times 450} = 175.35\,N$	3	8	8
	UNIT – II			
V a)	$d_o = 200$ mm, $d_i = 150$ mm $\tau_s = 50$ MPa $= 50\,N/mm^2$ $K = \frac{d_i}{d_o} = \frac{150}{200} = 0.75$	2		
	strength means the maximum torque that can be transmitted		7	7
	$T = \frac{\pi}{16} \tau d_o^3 (1-K^4)$	2		
	$= \frac{\pi}{16} \times 50 \times 200^3 (1-0.75^4)$ $= 53689327.58$ N-mm $= 53.69$ KN-m	3		
b)	Design of shaft Determine the mean torque, $T_{mean} = \frac{60P}{2\pi N}$ compute the maximum torque as per the given conditions if T_{max} is x% greater than T_{mean}, then $T_{max} = (100+x)\%$ of T_{mean} if the condition is not specified then $T_{max} = T_{mean}$	2		

SCHEME OF VALUATION

(Scoring Indicators)

Revision:		Course Code:		
Qst.No.	Scoring Indicator	Split Up	Sub total	Total
	Using strength equation determine the diameter of each shaft. $d = \sqrt[3]{\frac{16 T_{max}}{\pi \tau_s}}$ Adopt standard size of the shaft. Design of sleeve $D = 2d + 13$ $L = 3.5d$ Check the torsional shear stress induced in the sleeve by considering it to be as a hollow shaft. $T_{max} = \frac{\pi}{16} \tau_s D^3 (1-K^4)$ $\tau_s = \frac{16 T_{max}}{\pi D^3 (1-K^4)}$, $K = d/D$ τ_s must be less than the given permissible value.	2	3	8
	Design of Key Compare the given crushing and shearing stress for the key material If $\sigma_{ck} = 2\tau_k$ adopt square key otherwise adopt rectangular key width of key, $w = d/4$ $t = w$ – for square key, $t = d/6$ for rect. key $l = \frac{L}{2} = \frac{3.5d}{2}$ Check the torsional stress and crushing stress. $T_{max} = l w \tau_k \frac{d}{2}$, $\tau_k = \frac{2 T_{max}}{l \cdot w \cdot d}$ $T_{max} = l \cdot \frac{t}{2} \sigma_{ck} \cdot \frac{d}{2}$, $\sigma_{ck} = \frac{4 T_{max}}{l \cdot t \cdot d}$ These values must be less than the given values.		3	

SCHEME OF VALUATION

(Scoring Indicators)

Revision:		Course Code:		
Qst.No.	Scoring Indicator	Split Up	Sub total	Total
	OR			
VII a)	$P = 105\,KW = 105\times10^3\,W$, $N = 180\,rpm$ $\tau = 65\,MPa$, $l = 3.5\,m = 3.5\times10^3\,mm$ $\theta = 1^\circ$, $G = 80\times10^3\,N/mm^2$.			
	$T = \frac{60P}{2\pi N} = \frac{60\times105\times10^3}{2\pi\cdot180} = 6266.73\,N.m$ $= 6266.73\times10^3\,N.mm$	2		
	considering strength, $T = \frac{\pi}{16}\tau d^3$ $d = \sqrt[3]{\frac{16\times6266.73\times10^3}{\pi\times65}} = 78.89\,mm$	2	7	
	considering torsional rigidity Using rigidity equation, $\theta = \frac{584\,Tl}{Gd^4}$ $d = \sqrt[4]{\frac{584\times6266.73\times10^3\times3.5\times10^3}{80\times10^3\times1}}$ $= 112.49\,mm$	3		
	Take the larger value, $d = 112.49$ say $120\,mm$			
b)	strength eqn. for hollow shaft, $T_H = \frac{\pi}{16}\tau d_o^3(1-k^4)$ for solid shaft, $T_S = \frac{\pi}{16}\tau d^3$ $\therefore \frac{T_H}{T_S} = \frac{\frac{\pi}{16}\tau d_o^3(1-k^4)}{\frac{\pi}{16}\tau d^3} = \frac{d_o^3(1-k^4)}{d^3}$ —(1)			

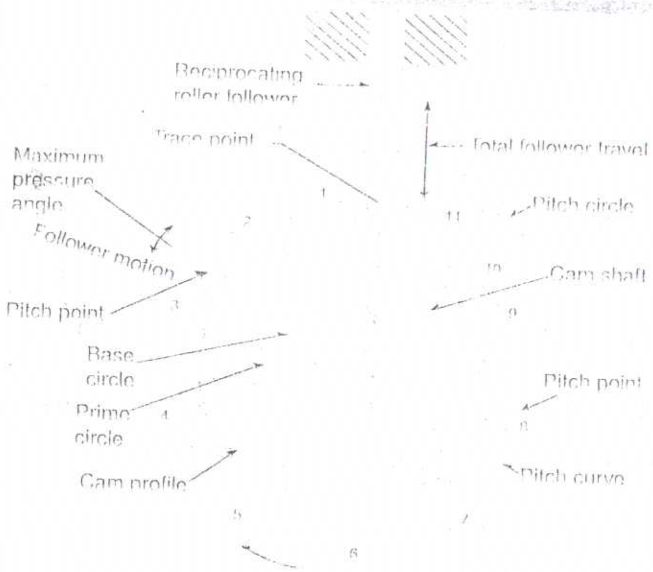
SCHEME OF VALUATION

(Scoring Indicators)

Revision:	Course Code:			
Qst.No.	Scoring Indicator	Split Up	Sub total	Total
	W_H weight of hollow shaft, W_H = Weight of solid shaft W_S. $A_H \times l_H \times \rho_H = A_S \times l_S \times \rho_S$ $A_H = A_S$ $l_H = l_S$, $\rho_H = \rho_S$ $\frac{\pi}{4}(d_o^2 - d_i^2) = \frac{\pi}{4} d^2$ $d_o^2 - d_i^2 = d^2$ $d_o^2\left(1-\left(\frac{d_i}{d_o}\right)^2\right) = d^2$ $d_o^2(1-K^2) = d^2$ $d = \sqrt{d_o^2(1-K^2)} = d_o\sqrt{1-K^2}$ (2) combining (1) & (2) $\frac{T_H}{T_S} = \frac{d_o^3(1-K^4)}{(d_o\sqrt{1-K^2})^3} = \frac{d_o^3(1-K^2)(1+K^2)}{d_o^3(1-K^2)\sqrt{(1-K^2)}}$ $\frac{T_H}{T_S} = \frac{1+K^2}{\sqrt{1-K^2}}$ Since, K is less than 1, suppose K = 0.5 then $\frac{T_H}{T_S} = \frac{1+0.5^2}{\sqrt{1-0.5^2}} = 1.44$. $\frac{T_H}{T_S} > 1$ or $T_H > T_S$ This shows that torque transmitted by the hollow shaft is greater than that of the solid shaft.			8

SCHEME OF VALUATION

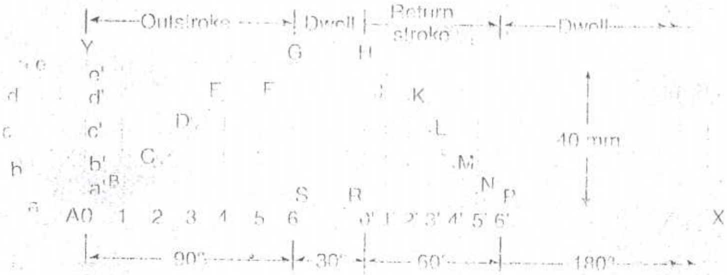
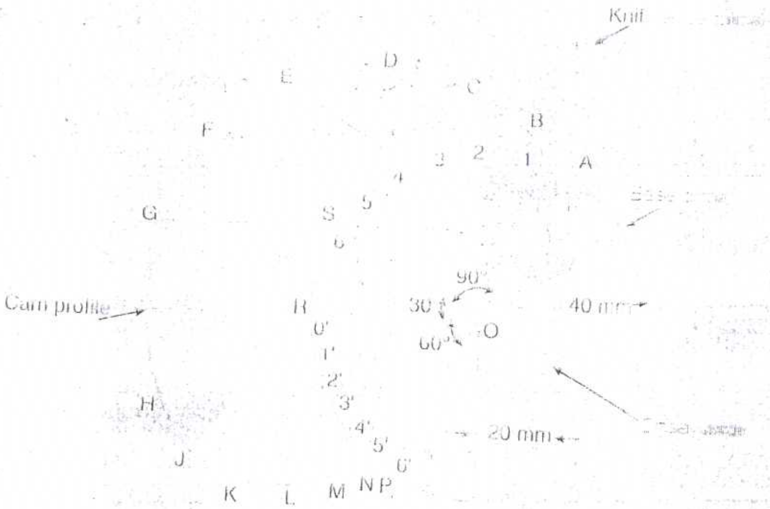
(Scoring Indicators)

Revision:		Course Code:		
Qst.No.	Scoring Indicator	Split Up	Sub total	Total
VII a)	UNIT - III 			7
b)	$d = 65\,mm = 65\times10^{-3}\,m$, $W = 5\times10^{3}\,N$ $N = 200\,rpm$, $l/d = 3$, $\mu = 0.02$ $l = 3d = 3\times65 = 195\,mm$ Projected area, $A = l\cdot d = 195\times65 = 12675\,mm^2$ $P_b = \frac{W}{A} = \frac{5\times10^{3}}{12675} = 0.39\,N/mm^2$	4		
	$V = \frac{\pi d N}{60} = \frac{\pi\times65\times10^{-3}\times200}{60} = 0.68\,m/s$	2	8	
	$Q_g = \mu W V = 0.02\times5\times10^{3}\times0.68$ $= 68\,W$ or J/s	2		

SCHEME OF VALUATION

(Scoring Indicators)

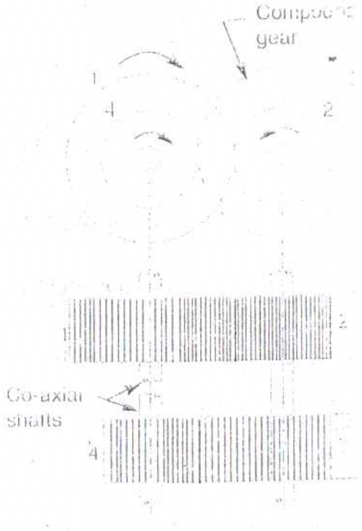
Revision: Course Code:

Qst.No.	Scoring Indicator	Split Up	Sub total	Total
VIII a)	OR. i) Depending upon the direction of load to be supported a) Radial bearing b) Thrust bearing	2		
	ii) Depending upon the nature of contact a) sliding contact bearing	2	7	7
	b) Rolling contact bearings (Brief note)	3		
b)		3		8
		5		

SCHEME OF VALUATION

(Scoring Indicators)

Revision: Course Code:

Qst.No.	Scoring Indicator	Split Up	Sub total	Total
IX	UNIT-IV a) When the axes of the first gear (driver) and the last gear (driven) are co-axial then the gear train is known as reverted gear training.  Reverted gear train.	Fig-4 note-1		7
	Applications – Automotive transmissions, lathe back gears, clocks etc.	–	2	
	b) $d = 600\,mm = 0.6\,m$, $N = 200\,rpm$ $\mu = 0.25$, $\theta = 160^\circ = \frac{160 \times \pi}{180} = 2.79\,rad.$			
	$V = \frac{\pi d N}{60} = \frac{\pi \times 0.6 \times 200}{60} = 6.283\,m/s.$		2	
	$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.25 \times 2.79} = 2.01$		2	8
	Power transmitted $P = T_1\left(1 - \frac{1}{e^{\mu\theta}}\right).V$ $= 25\left(1 - \frac{1}{2.01}\right) \times 6.283$ $= 7.893\,KW$		4	

SCHEME OF VALUATION

(Scoring Indicators)

Revision:		Course Code:		
Qst.No.	Scoring Indicator	Split Up	Sub total	Total
	OR			
X a)	Due to the insufficient frictional grip between the belt and its pulley sometimes the driving pulley moves without carrying the belt with it. The relative motion between the pulley and the belt is called the slip of the belt. When the belt passes from the slack side to the tight side, a certain portion of the belt extends and it contracts again when the belt passes from the tight side to slack side. Due to these change of length, there is a relative motion between the belt and the pulley surface. This relative motion is termed as creep.			7
b)	$d_1 = 300\,mm$, $N_1 = 200\,rpm$, $C = 3\times10^3\,mm$ $N_2 = 120\,rpm$, $t = 5\,mm$, $s = s_1 + s_2 = 6\%$ $\frac{N_2}{N_1} = \frac{d_1 + t}{d_2 + t}\left(1 - \frac{s}{100}\right)$ $d_2 = \left[(d_1 + t)\left(1 - \frac{s}{100}\right) \times \frac{N_1}{N_2}\right] - t$ $= \left[(300+5)\left(1 - \frac{6}{100}\right) \times \frac{200}{120}\right] - 5$ $= 472.83\,mm$		4	8
	$L_0 = \frac{\pi}{2}(d_2 + d_1) + 2C + \frac{(d_2 - d_1)^2}{4C}$ $= \frac{\pi}{2}(472.83 + 300) + 2\times3\times10^3 + \frac{(472.83 - 300)^2}{4\times3\times10^3}$ $= 7216.45\,mm = 7.22\,m$	4		