

Name:

Enrolment No:

Roll No.



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, July 2020

Course: Design of Machine Elements

Program: B.Tech. Mechatronics Engineering

Course Code: MECH3001

Instructions:

Semester: VI th Semester

Time 03 hrs.

Max. Marks: 100

1. Use of Design Data Handbook is allowed during the examination.

2. Assume the suitable data and mention in solution at start.

3. Draw the necessary diagrams.

Note:

1. Read the instruction carefully before attempting.
2. This question paper has one section, Section A.
3. There are total of six questions in this question paper **Section A**
4. **Section A** consist of design problems related to machine components and has the total weightage of **100%**.
5. **Section A** will be conducted online on BB Collaborate platform
6. **Section A** consist of long answer based questions and has the total weightage of **100%**. The questions for section B shall also appear in BB Collaborate
8. **Section A** to be submitted within **05 hrs** from the scheduled time (*exceptional provision due extraordinary circumstance due to COVID-19 and due to internet connectivity issues in the far-flung areas*).
9. No submission of **Section A** shall be entertained after 05 Hrs.
10. The **section A** should be attempted in blank white sheets (hand written) with all the details like programme, semester, course name, course code, name of the student, Sapid at the top (as in the format) and signature at the bottom (right hand side bottom corner)
12. Section A questions are from entire syllabus.
13. The COs mapping, internal choices within a section is same as earlier

Section – A (Attempt all the questions)

Use of Design data handbook (DDHB) is allowed while solving the problems.

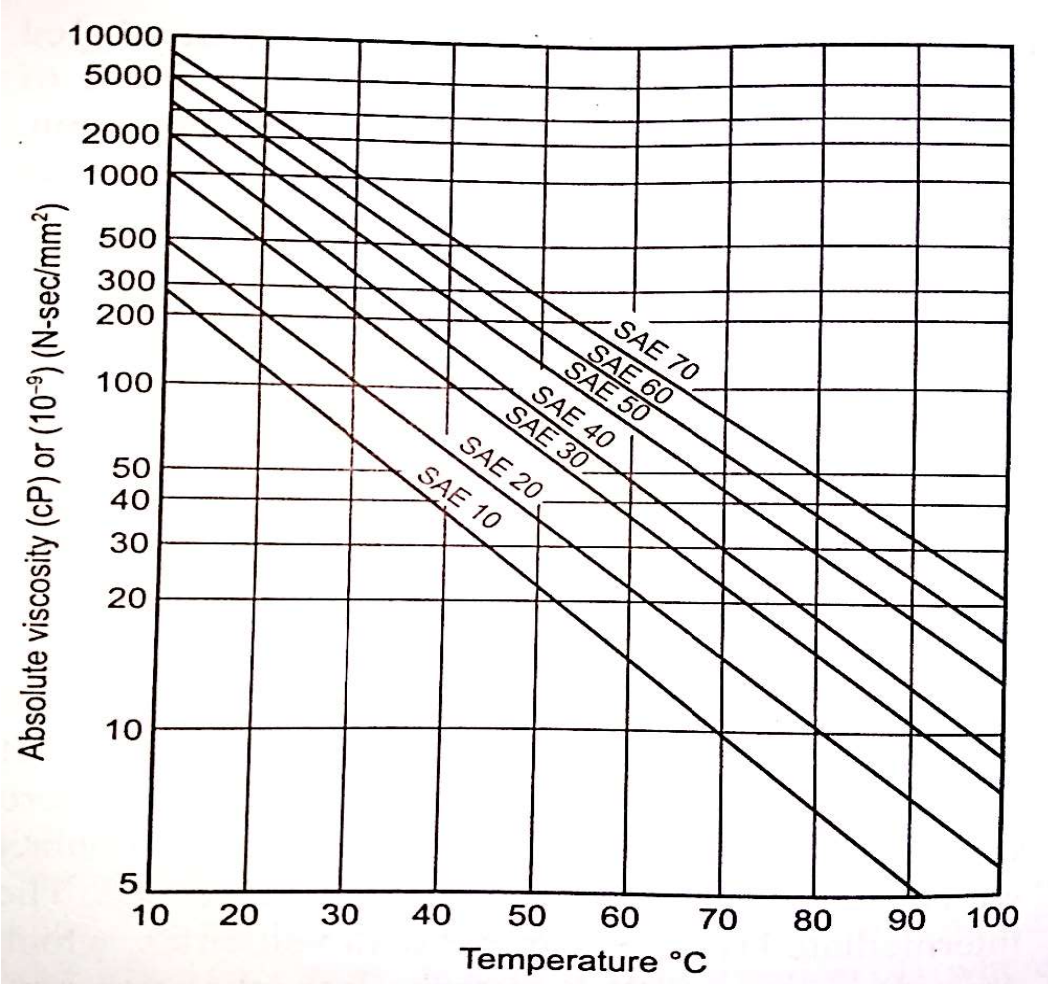
*Paper consisting of **Six Design** problems of machine components. Assume the suitable data if not provided from DDHB. Time duration to solve the problems are limited to 5 hrs for each student which includes the submission of the solution through mail. Any issue may be escalated to concern faculty member through mail/WhatsApp etc.*

Q.P. 1

500054086	R880216018	MANVENDRA SINGH
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S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	A pressure vessel of the boiler consists of cylindrical shell of 1.2 m inner diameter is subjected to internal steam pressure of 2 MPa. Design a suitable longitudinal riveted butt joint which can be used to make the shell. Permissible stresses for rivet and shell in tension, shear and compression are 80, 60 and 120 N/mm ² respectively. Design the joint completely and support with the suitable diagrams.	15	CO3
Q 2	A mild steel shaft has to transmit 40 kW power at 200 rpm with is couple to a machine. Consider the appropriate material for shaft, flange, bolt and key to design the protective type of flange coupling Also draw the diagram of flange coupling designed with all dimensions.	15	CO3
Q 3	A shaft is supported by two bearings which are 1.3 m apart. A 750 mm diameter pulley is fixed at a distance of 400mm to right of left hand bearing, this drives a pulley directly below it with belt drive having max tension 2 kN. Another pulley 500 mm diameter is placed at 400 mm left of right hand bearing which is driven by motor. Consider the angle of wrap 180° and coefficient of friction = 0.25 for belt drive. Assume the suitable data, draw configuration diagram and design the shaft.	15	CO2/ CO4
Q 4	A compressor running at 300 RPM is driven by a 20 KW 1200RPM Motor through a 20-degree full depth involute gear. The center distance is 250 mm. Choosing the suitable material for pinion and gear, Design the spur gear drive completely. Assume medium shock condition and other suitable data if any.	25	CO4
Q 5	(a)Design a journal bearing for following data used for steam turbine application ; Load W= 22500 N Journal speed =1440 rpm Assume following : Journal diameter or l/d ratio to maintain the pressure as recommended for the application (here steam turbine), other relevant data (Lubricating oil and operating temperature) and design completely the journal bearing by maintaining the hydrodynamic lubrication conditions. Make the conclusions if any. (b) Select a suitable ball bearing (Deep groove ball bearing) for the spindle of a drilling machine rotating at 1200 rpm. The bearing is subjected to radial load of 3000N and a thrust load of 2000N. The machine is to work for 8 hours/day for a service life of 5.5 years. Suggest the diameter of spindle for which bearing can be used.	30	CO2/ CO4

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



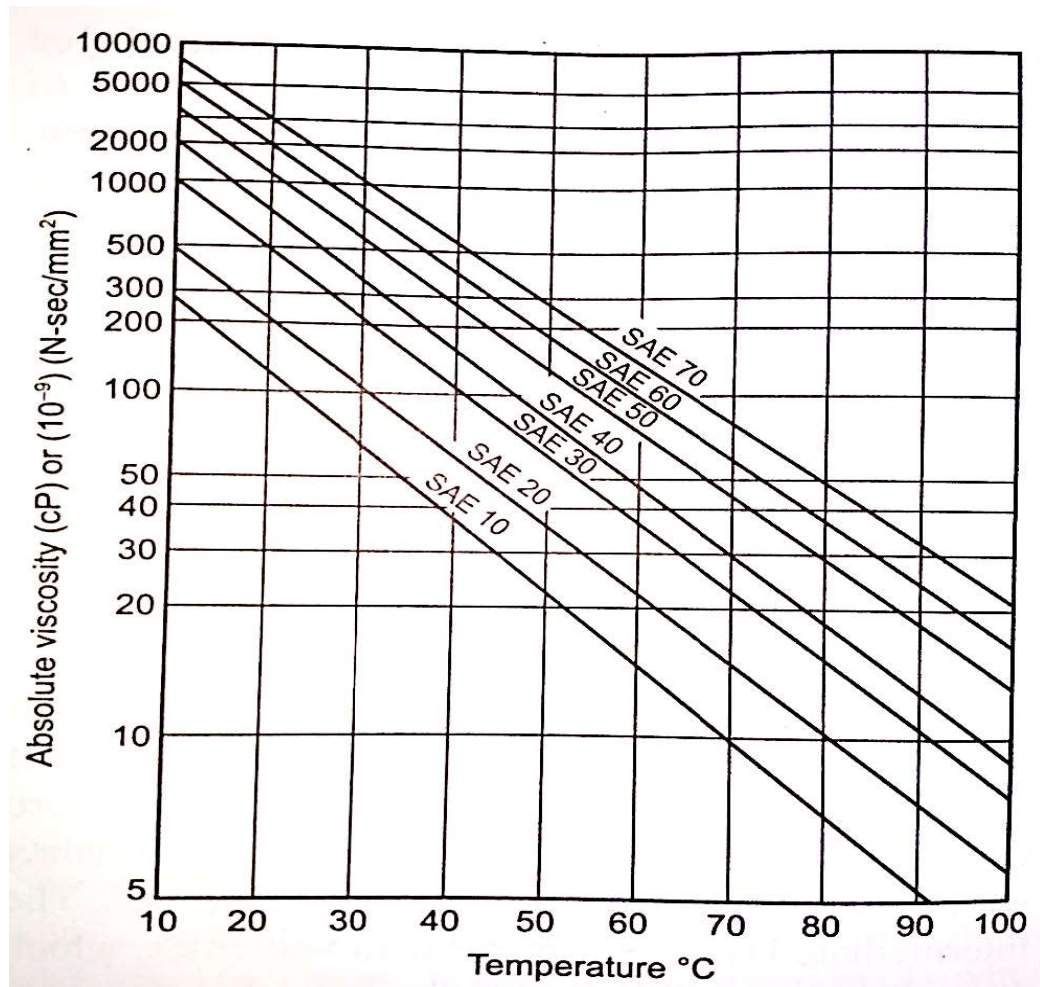
Q.P. 2

500062798	R880217001	ABHINAB DUTTA
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S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	A pressure vessel of the boiler consists of cylindrical shell of 1.5 m inner diameter is subjected to internal steam pressure of 2 MPa. Design a suitable longitudinal riveted butt joint which can be used to make the shell. Permissible stresses for rivet and shell in tension, shear and compression are 80, 60 and 120 N/mm ² respectively. Design the joint completely and support with the suitable diagrams.	15	CO3
Q 2	A mild steel shaft has to transmit 40 kW power at 200 rpm with is couple to a machine.. Consider the appropriate material for shaft, flange, bolt and key to design the protective type of flange coupling Also draw the diagram of flange coupling designed with all dimensions.	15	CO3
Q 3	A shaft is supported by two bearings which are 1.5 m apart. A 750 mm diameter pulley is fixed at a distance of 400mm to right of left hand bearing, this drives a pulley directly below it with belt drive having max tension 2.5 kN. Another pulley 500 mm diameter is placed at 500 mm left of right hand bearing which is driven by motor. Consider the angle of wrap 180° and coefficient of friction = 0.22 for belt drive. Assume the suitable data, draw configuration diagram and design the shaft	15	CO2/ CO4
Q 4	A compressor running at 300 RPM is driven by a 10 KW 900 RPM Motor through a 20-degree full depth involute gear. The center distance is 200 mm. Choosing the suitable material for pinion and gear, Design the spur gear drive completely. Assume medium shock condition and other suitable data if any.	25	CO4
Q 5	(a)Design a journal bearing for following data used for centrifugal pump application ; Load W= 22000 N Journal speed =1500 rpm Assume following : Journal diameter or l/d ratio to maintain the pressure as recommended for the application (here centrifugal pump), other relevant data (Lubricating oil and operating temperature) and design completely the journal bearing by maintaining the hydrodynamic lubrication conditions. Make the conclusions if any. (b) Select a suitable ball bearing (Angular contact bearing) for the spindle of a drilling machine rotating at 1200 rpm. The bearing is subjected to radial load of 4000N and a thrust	30	CO2/ CO4

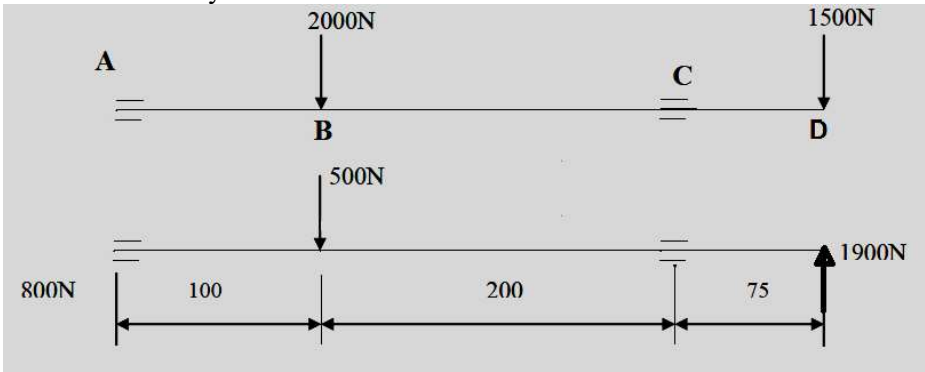
load of 3000N. The machine is to work for 10 hours/day for a service life of 5 years. Suggest the diameter of spindle for which bearing can be used.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



Q.P. 3

500062623	R880217002	ABHINAV MUDGAL
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S. No.	Statement of question	Marks	CO																								
SECTION A																											
Q 1	Design a riveted Joint in which the pitch of the rivets in the outer row is twice that in the inner rows. Diameter of boiler shell is 1100 mm and is subjected to internal pressure of 1.8 N/mm^2 . Consider the working stresses as $\sigma_t = 90 \text{ MPa}$ in tension, $\sigma_c = 135 \text{ MPa}$ in compression, and $\tau = 70 \text{ MPa}$ in shear for the joint.	15	CO3																								
Q 2	Determine the dimension of flange coupling that connect a motor and a pump shaft. The power to be transmitted a 4KW at a shaft speed of 1200 rpm. Select suitable material for the parts of the couplings and list the dimensions	15	CO3																								
Q 3	<p>Fig shows the forces acting on a steel shaft carrying two gears. The gears are keyed to the shaft at B and D. A and C are journal bearing centers. 6 KW is transmitted at 650 rev/min of the shaft. The allowable shear stress for an unkeyed section is 80 MN/m^2, Shaft is subjected to minor shock load only.</p> <p>Sketch horizontal, vertical and resultant bending moment diagrams, shows values at change points.</p> <p>Also determine the necessary shaft diameter.</p> 	15	CO2/ CO4																								
Q 4	Design a pair of spur gear for following data to transmit 15 kW of power available at pinion for speed reduction ratio of 3: 1 ; Assume speed of pinion as 900 mm.	25	CO4																								
	<table border="1"> <thead> <tr> <th>Detail</th> <th>Pinion</th> <th>Gear</th> </tr> </thead> <tbody> <tr> <td>Material</td> <td>Semi Steel</td> <td>Cast Iron</td> </tr> <tr> <td>Design Stress</td> <td>84 MPa</td> <td>56 Mpa</td> </tr> <tr> <td>BHN</td> <td>200</td> <td>160</td> </tr> <tr> <td>Speed</td> <td>1600</td> <td>400</td> </tr> <tr> <td>Tooth Profile</td> <td>20^0</td> <td>20^0</td> </tr> <tr> <td>σ_{en}</td> <td>170 Mpa</td> <td>84 Mpa</td> </tr> <tr> <td>Modulus of Elasticity</td> <td>210 Gpa</td> <td>100 Gpa</td> </tr> </tbody> </table>	Detail	Pinion	Gear	Material	Semi Steel	Cast Iron	Design Stress	84 MPa	56 Mpa	BHN	200	160	Speed	1600	400	Tooth Profile	20^0	20^0	σ_{en}	170 Mpa	84 Mpa	Modulus of Elasticity	210 Gpa	100 Gpa		
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BHN	200	160
Centre distance	250 mm	

Check the gear for dynamic loading and make the conclusions.

Q 5

(a) Suggest the rolling contact bearing(Deep groove Ball) for the loading conditions;

Axial force = 5000 N

Radial force = 4000 N

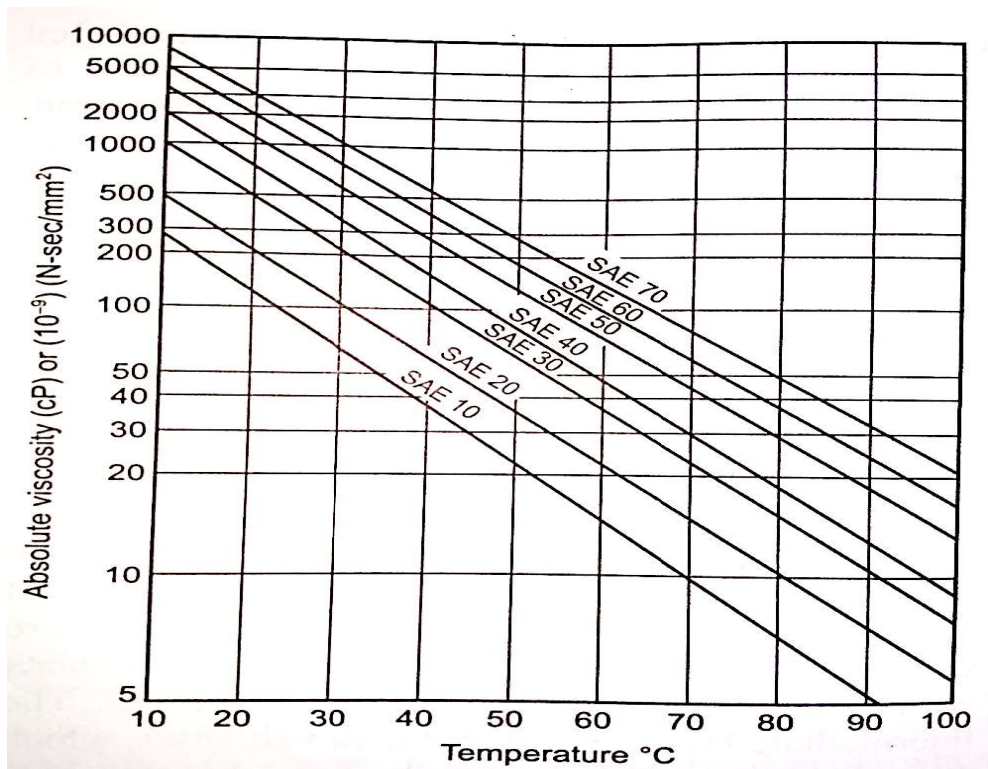
Speed =1500 rpm

Desired Life = 5 years by assuming 8 hours working in a day

Assume the uniform and steady load .Suggest the shaft diameter.

(b) Suggest the bearing for journal diameter of 80 mm to be used for centrifugal pump application. Load applied to bearing is 15 kN and its speed is 900 rpm. Complete the design calculation for bearing. Mention clearly the data assumed in solution; lubricating oil, bearing characteristic numbers etc.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



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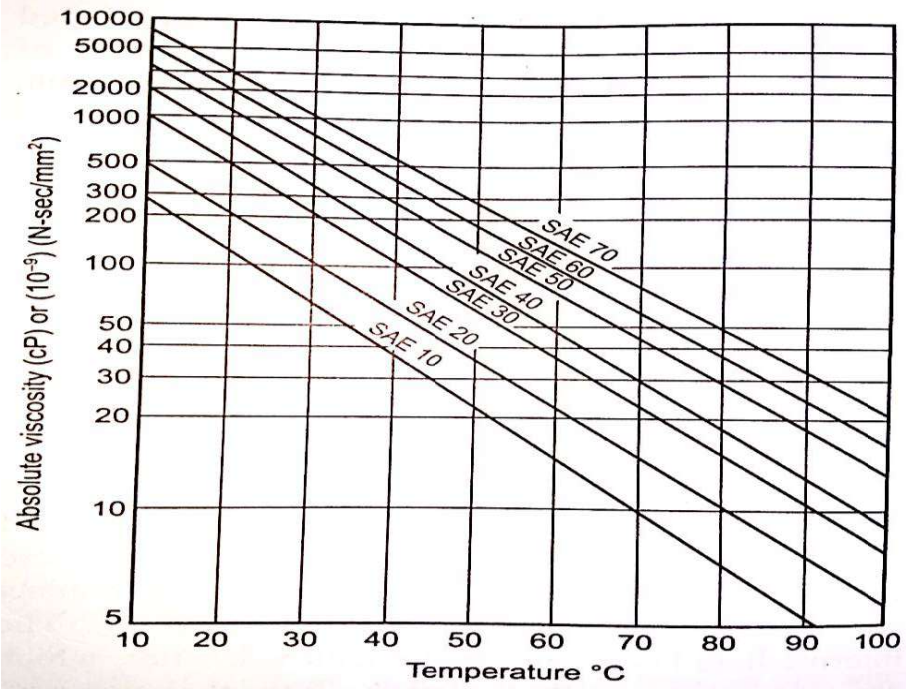
CO2/C
O4

Q.P. 4

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S. No.	Statement of question	Marks	CO									
SECTION A												
Q 1	Design a riveted Joint in which the pitch of the rivets in the outer row is twice that in the inner rows. Diameter of boiler shell is 1400 mm and is subjected to internal pressure of 1.8 N/mm^2 . Consider the working stresses as $\sigma_t = 90 \text{ MPa}$ in tension, $\sigma_c = 135 \text{ MPa}$ in compression, and $\tau = 70 \text{ MPa}$ in shear for the joint.	15	CO3									
Q 2	Determine the dimension of flange coupling that connect a motor and a pump shaft. The power to be transmitted a 6 KW at a shaft speed of 1200 rpm. Select suitable material for the parts of the couplings and list the dimensions	15	CO3									
Q 3	The figure is a schematic drawing of a shaft that supports two V-belt pulleys. The loose belt tension on the pulley at A is 15% of the tension on the tight side. The shaft material has a yield strength of 300 MN/m^2 and an ultimate tensile strength of 520 MN/m^2 . Design the shaft either by assuming FOS or by using ASME codes. Consider the rotating shaft subjected to gradually applied load.	15	CO2/ CO4									
Q 4	Design a pair of spur gear for following data to transmit 20 kW of power available at pinion for speed reduction ratio of 4: 1 ;	25	CO4									
<table border="1"> <thead> <tr> <th>Detail</th> <th>Pinion</th> <th>Gear</th> </tr> </thead> <tbody> <tr> <td>Material</td> <td>Semi Steel</td> <td>Cast Iron</td> </tr> <tr> <td>Design Stress</td> <td>84 MPa</td> <td>56 Mpa</td> </tr> </tbody> </table>				Detail	Pinion	Gear	Material	Semi Steel	Cast Iron	Design Stress	84 MPa	56 Mpa
Detail	Pinion	Gear										
Material	Semi Steel	Cast Iron										
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Centre distance	300 mm																							
Q 5	<p>(b) Suggest the rolling contact bearing (Angular contact bearing Ball) for the loading conditions;</p> <p>Axial force = 5000 N</p> <p>Radial force = 4000 N</p> <p>Speed =1500 rpm</p> <p>Desired Life = 6 years by assuming 8 hours working in a day</p> <p>Assume the uniform and steady load .Suggest the shaft diameter.</p> <p>(b) Suggest the bearing for journal diameter of 80 mm to be used for centrifugal pump application. Load applied to bearing is 15 kN and its speed is 900 rpm. Complete the design calculation for bearing. Mention clearly the data assumed in solution; lubricating oil, bearing characteristic numbers etc.</p> <p>Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing) Q.No.5</p>	30	CO2/C04																					



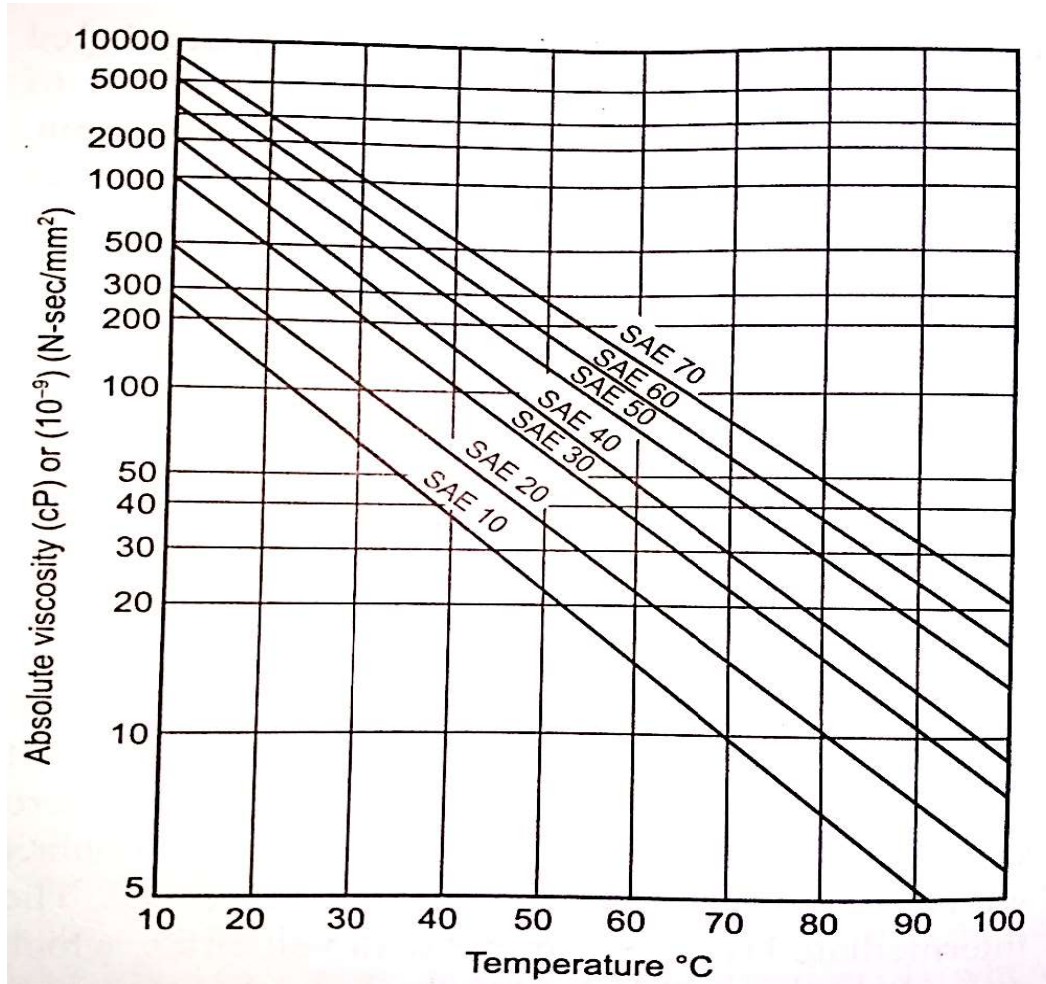
Q.P. 5

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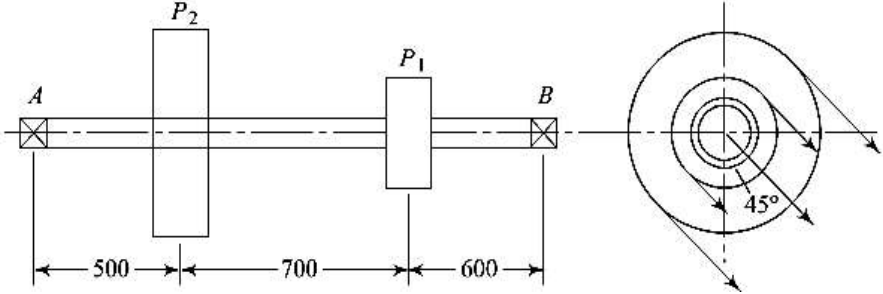
S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	A steam boiler is to be designed for a working pressure of 2.1 N/mm ² with its inside diameter 1.5 m. Give the design calculations for the longitudinal riveted joints for the following working stresses for steel plates and rivets : In tension = 75 MPa ; In shear = 60 MPa; In crushing = 125 MPa. Select the suitable riveted joint to be designed by using DDHB as recommended by IBR and draw the joints.	15	CO3
Q 2	Design a rigid coupling to transmit 7.5 kW power at 720 rpm. Design torque may be considered as 150% of the average torque. Shaft and bolts are made of plain carbon steel 30C8 ($\sigma_y = 400$ N/mm ²) and FOS =5. $\sigma_c = 1.5 \sigma_y$, and $\tau = 0.5 \sigma_y$. Flange is made of CI and allowable shear stress can be taken as 30 MPa.	15	CO3
Q 3	A transmission shaft, supporting two pulleys A and B mounted between two bearings C1 & C2 as shown in figure. Power is transmitted from the pulley A to B. Assume the suitable material of shaft; any grade carbon steel between C35 to C50, design the shaft by using ASME codes. Assume that pulleys are keyed to the shaft. Wight of pulleys are 2 kg and 5 kg respectively. Dimensions indicated in diagram are taken in mm.	15	CO2/ CO4
Q 4	A pair of 20° full-depth involute tooth spur gears is to transmit 30 kW at a speed of 1000 r.p.m. of the pinion. The speed reduction ratio is 3: 1. Keep in mind the space limitation. Assume suitable different materials for gear & pinion. Design the gear assembly completely. Also check the gear in wear and suggest the suitable BHN.	25	CO4
Q 5	(a) Design a journal bearing for following data used: Load W= 15 kN Journal speed =1000 rpm Assume suitable data (application, lubricating oil, and operating temperature etc) and design completely the journal bearing. Make conclusions if any.	30	CO2/C O4

- (b) Select a suitable ball bearing for the head stock of lathe machine rotating at 1500 rpm. The bearing is subjected to radial load of 4500N and a thrust load of 3000N. The machine is to work for 10 hours/day for a service life of 6 years. Suggest the diameter of spindle for which bearing can be used.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



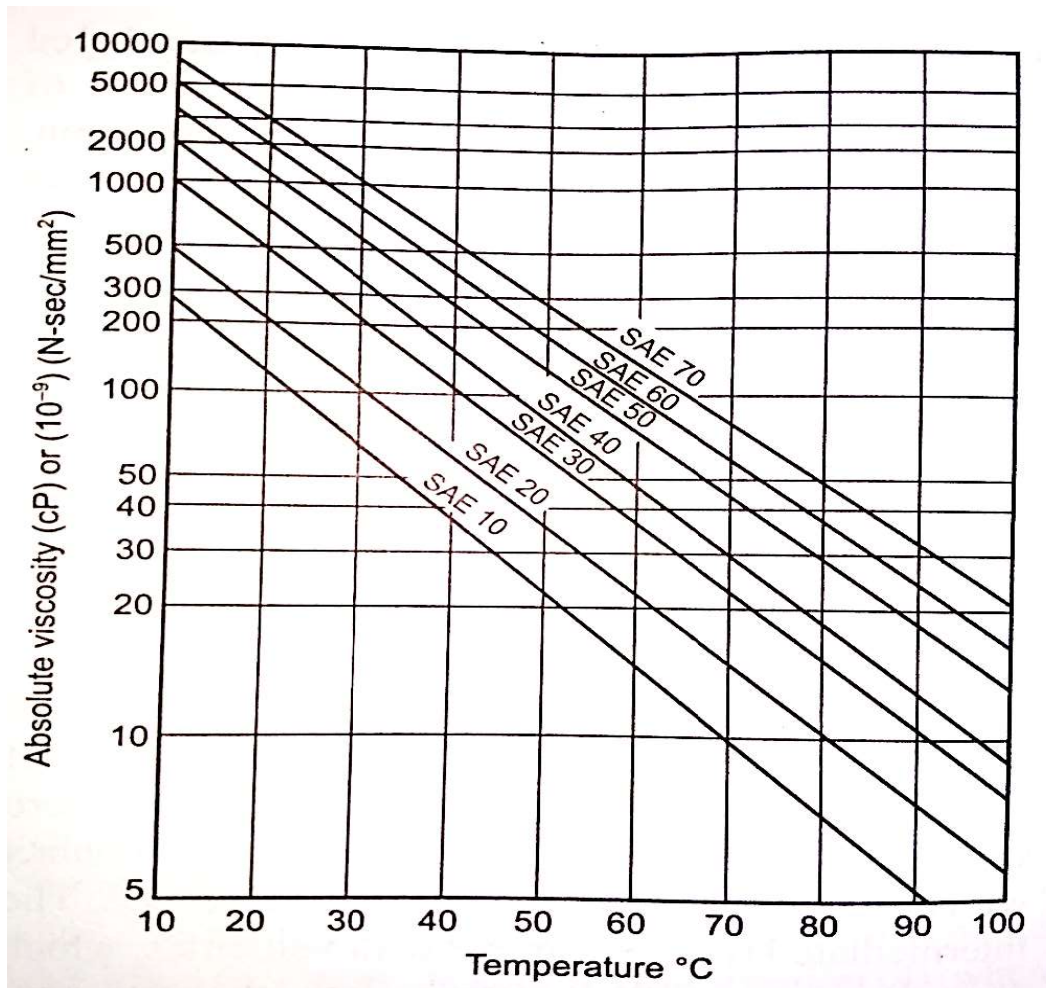
Q.P. 6

S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	<p>Design a longitudinal riveted joint for boiler shell the following data;</p> <p>Diameter of boiler shell = 1500 mm Maximum internal pressure = 2.5 N/mm² Strength of plate in tension = 84 MPa Crushing strength of plate = 130 MPa Shearing strength of rivet = 70 MPa Assume the relevant data from DDHB.</p> <p>Select a suitable riveted joint to be designed. Suggest the diagram for designed joint.</p>	15	CO3
Q 2	<p>A rigid coupling transmits 35 kW at 180 rpm. The service factor for the application is 1.5 (take design torque as 1.5 times the mean torque). Select the suitable material for the various parts of the coupling. Take the material for shaft as 40C8 ($\sigma_y = 380$ MPa), material for bolts is 30C8 (400 MPa) and flanges are made up of cast iron FG 150 ($\sigma_{ut} = 150$ MPa). Take factor of safety as 3 for all components. Also draw neat sketch of the coupling.</p>	15	CO3
Q 3	<p>Design a line shaft transmitting power to two machine tools. The power received by the shaft is 30kW at 300 rpm. The power absorbed by pulley P₁ is 12 kW and the remaining power is absorbed by pulley P₂. The diameter of pulley P₁ is 300 mm and its mass is 40 kg. The diameter and mass of pulley P₂ are 600 mm and 75 kg respectively. Assume the belt tension ratio of 2 for both pulleys, design the shaft as per ASME code.</p>  <p>All the dimensions are in mm.</p>	15	CO2/ CO4
Q 4	<p>A pair tooth of spur gear is to transmit 12 kW power at a speed of 1500 r.p.m. from pinion to gear for speed reduction ratio of 2: 1. Assume the suitable data and materials from the design data handbook as required.</p>	25	CO4

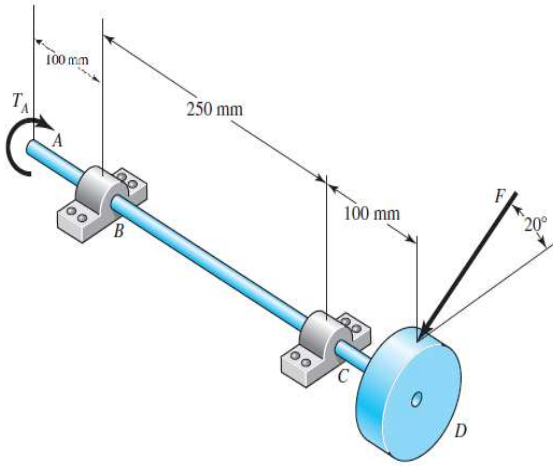
Design the gear assembly from static point of view. Also check the gear assembly in wear and suggest the suitable BHN

- Q 5
- (a) Suggest the bearing for journal diameter of 100 mm to be used for centrifugal pump application. Load applied to bearing is 16 kN and its speed is 1000 rpm. Complete the design calculation for bearing. Mention clearly the data assumed in solution; lubricating oil, bearing characteristic numbers etc.
 - (b) Select a suitable ball bearing for the head stock of lathe machine rotating at 1500 rpm. The bearing is subjected to radial load of 5000N and a thrust load of 3500N. The machine is to work for 12 hours/day for a service life of 6 years. Suggest the diameter of spindle for which bearing can be used.

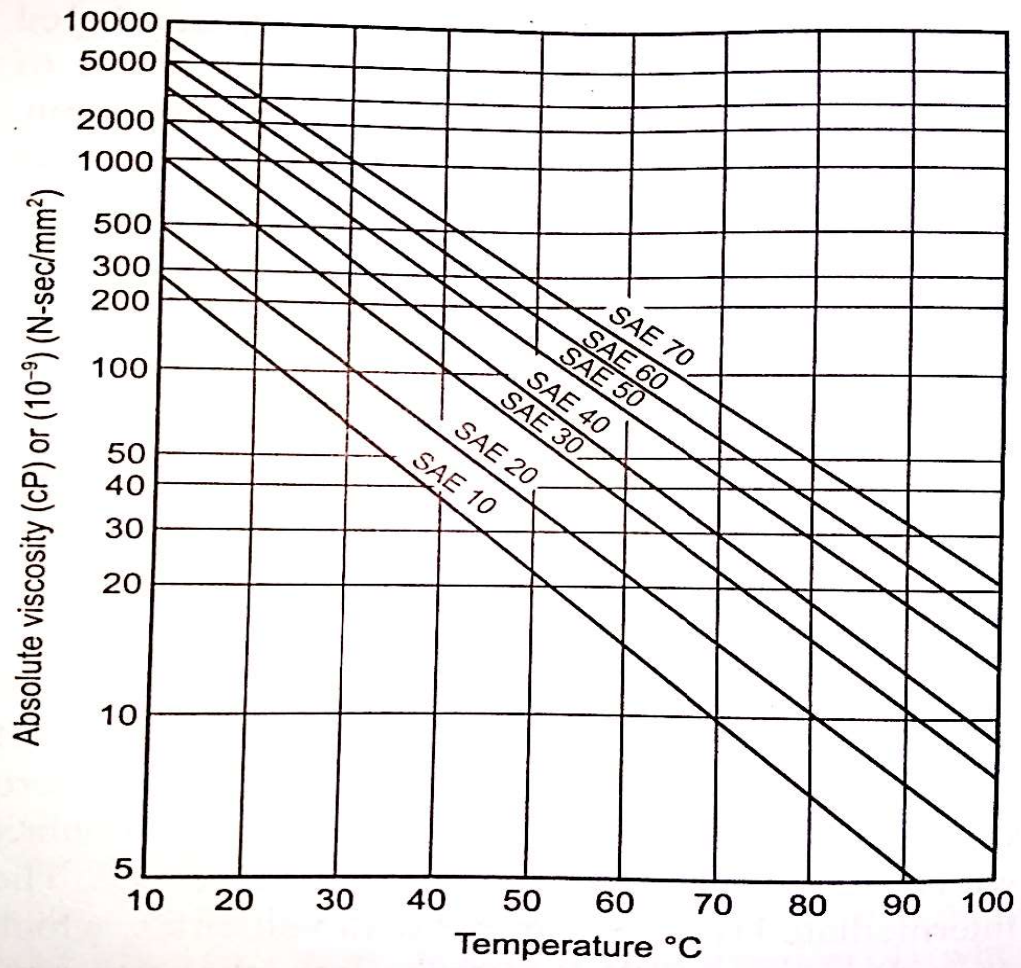
Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



Q.P. 7

S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	<p>Design a longitudinal riveted joint for boiler shell the following data;</p> <p>Diameter of boiler shell = 1800 m Maximum internal pressure = 2N/mm² Strength of plate in tension = 85 MPa Crushing strength of plate = 120 MPa Shearing strength of rivet = 60 MPa Assume the relevant data from DDHB.</p> <p>Select a suitable riveted joint to be designed. Suggest the diagram for designed joint.</p>	15	CO3
Q 2	<p>A protected type flanged coupling is required to transmit 60 kw power at 1440 rpm. Design the coupling with following materials, Material for shaft material for shaft as 40C8 ($\sigma_y = 380$ MPa), material for bolts is 30C8 (400 MPa) and flanges are made up of cast iron FG 150 ($\sigma_{ut} = 150$ MPa). Take factor of safety as 2 for all components</p>	15	CO3
Q 3	<p>The rotating shaft is simply supported by bearings at points B and C and is driven by a gear (not shown) which meshes with the spur gear at D, which has a 200 mm pitch diameter. Consider the mass of gear as 5 kg. The force F from the drive gear acts at a pressure angle of 20°. The shaft transmits a torque to point A of $T_A = 500$ Nm. Using a factor of safety of 4, determine diameter of the shaft. Consider appropriate material of the shaft.</p>  <p>All the dimensions are in mm.</p>	15	CO2/ CO4
Q 4	<p>A compressor running at 500 rpm is driven by a 20 kW 1500 rpm motor through 20 °full depth gears. The Centre distance is 300 m m. The pinion is to be made of C30 forged steel hardened and tempered. The gear is to be made of cast steel. Assuming medium shock condition design</p>	25	CO4

	<p>the gear completely for static and dynamic loading condition. Properties of materials of gear and pinion may be selected from the table as given below;</p> <table border="1" data-bbox="199 259 1161 533"> <thead> <tr> <th data-bbox="199 259 507 376">Material</th> <th data-bbox="507 259 695 376">Allowable static design stress</th> <th data-bbox="695 259 919 376">Endurance strength</th> <th data-bbox="919 259 991 376">BH N</th> <th data-bbox="991 259 1161 376">Modulus of Elasticity</th> </tr> </thead> <tbody> <tr> <td data-bbox="199 376 507 454">C30 forged steel hardened and tempered</td> <td data-bbox="507 376 695 454">224 MPa</td> <td data-bbox="695 376 919 454">300 MPa</td> <td data-bbox="919 376 991 454">250</td> <td data-bbox="991 376 1161 454">210 GPa</td> </tr> <tr> <td data-bbox="199 454 507 533">Cast steel</td> <td data-bbox="507 454 695 533">140 MPa</td> <td data-bbox="695 454 919 533">225 MPa</td> <td data-bbox="919 454 991 533">160</td> <td data-bbox="991 454 1161 533">190 GPa</td> </tr> </tbody> </table>	Material	Allowable static design stress	Endurance strength	BH N	Modulus of Elasticity	C30 forged steel hardened and tempered	224 MPa	300 MPa	250	210 GPa	Cast steel	140 MPa	225 MPa	160	190 GPa		
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C30 forged steel hardened and tempered	224 MPa	300 MPa	250	210 GPa														
Cast steel	140 MPa	225 MPa	160	190 GPa														
Q 5	<p>(a) Select a suitable bearing (with explanation of selection) for an axial flow compressor having a radial load of 2500 N and an axial thrust of 1500 N. Shaft is running at 720 rpm and the desired life is 20000 hours.</p> <p>(b) Design a journal bearing to be used in a centrifugal pump having diameter of 150 mm running at 1200 rpm. Consider the radial load on bearing as 22.70 KN. Assume the suitable lubricating oil and suggest whether cooling is required or not.</p> <p>Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing) Q.No.5</p>	30	CO2/C04															



5000610 03	R8802170 11	HARSHIT ARORA
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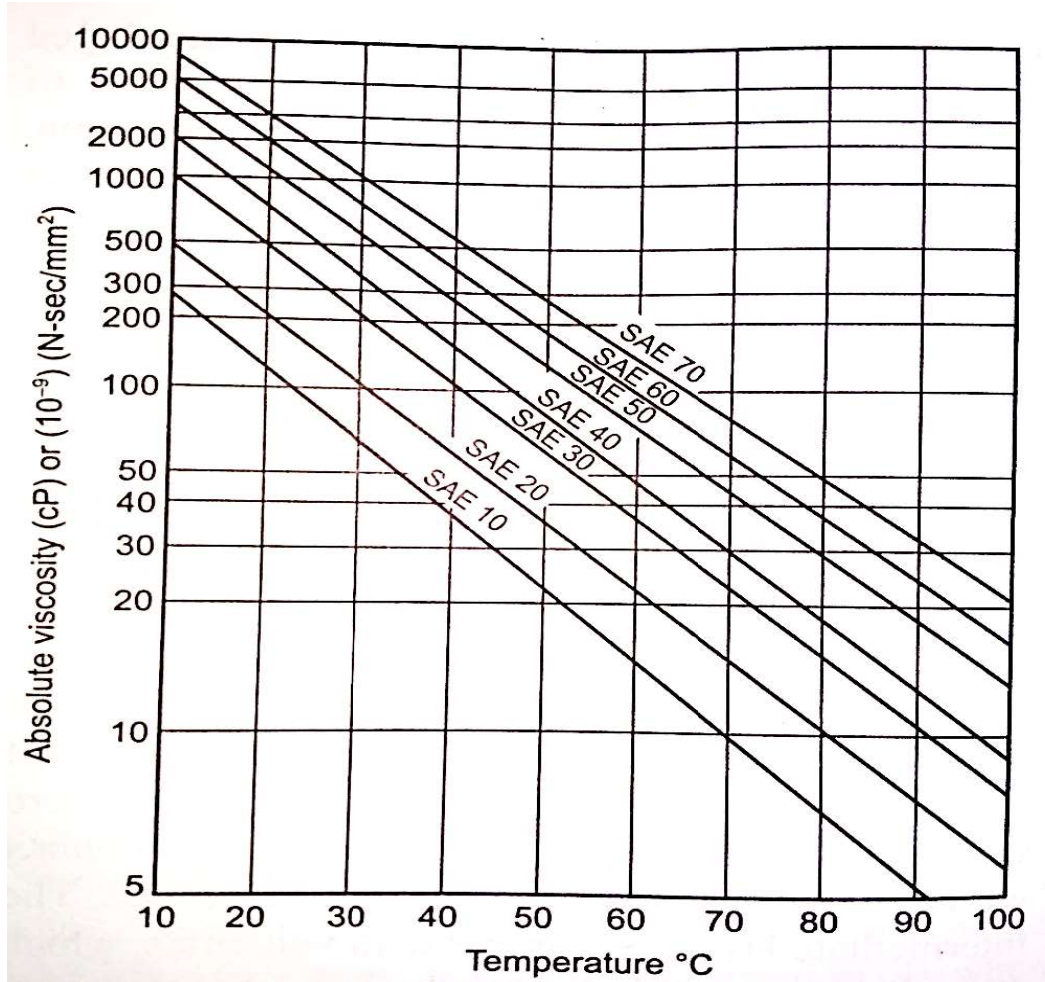
Q.P. No. 8

S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	Design a longitudinal riveted joint for boiler shell the following data; Diameter of boiler shell = 1.5 m Maximum internal pressure = 1.8 N/mm ² Strength of plate in tension = 80 MPa Crushing strength of plate = 120 MPa Shearing strength of rivet = 50 MPa Assume the relevant data from DDHB.	15	CO3
Q 2	A protected type flanged coupling is required to transmit 60 kw power at 1440 rpm. Design the coupling with following materials, Material for shaft material for shaft as 40C8 ($\sigma_y = 380$ MPa), material for bolts is 30C8 (400 MPa) and flanges are made up of cast iron FG 150 ($\sigma_{ut} = 150$ MPa). Take factor of safety as 2 for all components	15	CO3
Q 3	A shaft made of steel 40C8 is used to transmit 7.5 kW at 1440 rpm. A pulley mounted on the shaft has a diameter of 0.4 m and ratio of belt tensions is 3.5, as given in figure below. The teeth on gear of 250 mm pitch circle diameter has a 20° involute profile. Assume the equal torque on gear and pulley, design the shaft by using the ASME code. Draw the applicable force diagrams, Bending moment diagrams etc.	15	CO2/ CO4
Q 4	Two parallel shafts are connected by a pair of steel spur gear. The pinion transmits 20 KW at 1000RPM of the pinion. Both gear and pinion are made of same material. If the velocity ratio is 5:1. Assume the minimum no. of teeth as 30. Consider the appropriate materials. Also, check the gear in wear and suggest the required BHN for designed gear. Make the conclusions.	25	CO4
Q 5	(a) Select an angular contact ball bearing for a radial load of 10000 N and an axial load of 12000 N, operating at a speed of 1200 rpm. For an average life of 4 years at 10 hours per day. Assume uniform and steady load. Suggest the	30	CO2/C O4

angular contact bearing after assuming the suitable value of angle for angular contact bearing.

- (b) Design a journal bearing for a centrifugal pump from the following data:
Load on the journal = 20 000 N, Speed of the journal = 900 rpm. Type of oil is SAE 30. Ambient temperature of oil = 15.5°C.
Assume the operating temperature in range of 55°C to 75°C.
Make the conclusion about the cooling of bearing based upon the calculation.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5

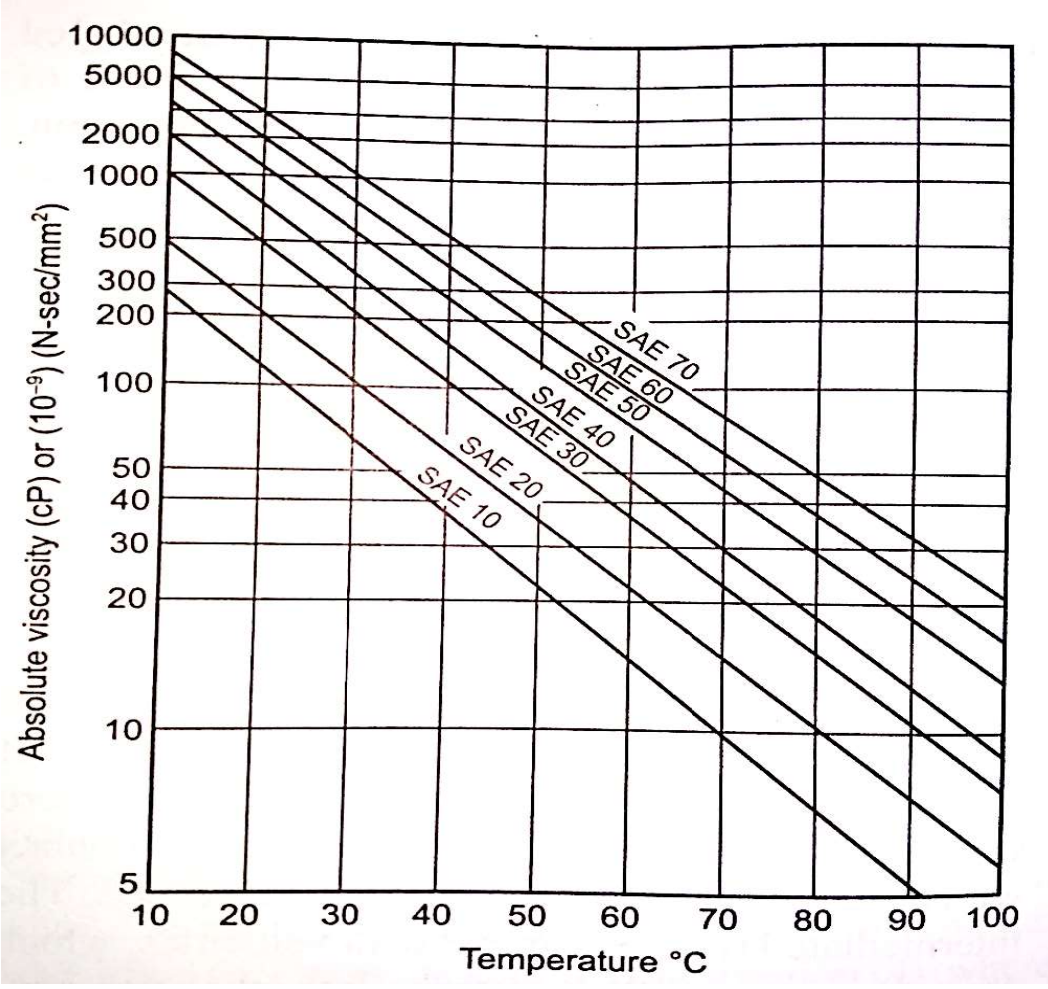


Q.P.. 9

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S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	A pressure vessel of the boiler consists of cylindrical shell of 1.2 m inner diameter is subjected to internal steam pressure of 1.5MPa. Design a suitable longitudinal riveted butt joint which can be used to make the shell. Permissible stresses for rivet and shell in tension, shear and compression are 70, 50 and 100 N/mm ² respectively. Design the joint completely and support with the suitable diagrams.	15	CO3
Q 2	A mild steel shaft has to transmit 25 kW power at 500 rpm which is couple to a machine. Consider the appropriate material for shaft, flange, bolt and key to design the protective type of flange coupling Also draw the diagram of flange coupling designed with all dimensions.	15	CO3
Q 3	A shaft is supported by two bearings which are 2.0 m apart. A 750 mm diameter pulley is fixed at a distance of 500mm to right of left hand bearing, this drives a pulley directly below it with belt drive having max tension 2.5 kN. Another pulley 500 mm diameter is placed at 500 mm left of right hand bearing which is driven by motor. Consider the angle of wrap 180° and coefficient of friction = 0.30 for belt drive. Assume the suitable data, draw configuration diagram and design the shaft.	15	CO2/ CO4
Q 4	A compressor running at 250 RPM is driven by a 10 KW 750 RPM Motor through a 20-degree full depth involute gear. The center distance is 150 mm. Choosing the suitable material for pinion and gear, Design the spur gear drive completely. Assume medium shock condition and other suitable data if any.	25	CO4
Q 5	(a)Design a journal bearing for following data used for Gas and oil engines, four stroke for main bearing application ; Load W= 10 kN Journal speed =2000 rpm Assume following : Journal diameter or l/d ratio to maintain the pressure as recommended for the application (Gas and oil engines, four stroke), other relevant data (Lubricating oil and operating temperature) and design completely the journal bearing by maintaining the hydrodynamic lubrication conditions. Make the conclusions if any. (b) This required to select a bearing with slight misalignment to be taken care of for the given input data for machine running at 1200 rpm. The bearing is subjected to radial load of 3000N and a thrust load of 2000N. The machine is to work for 10hours/day for a service life of 5 years. Suggest the diameter of spindle for which bearing can be used .Make your solution and justify for the selected bearings.	30	CO2/ CO4

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



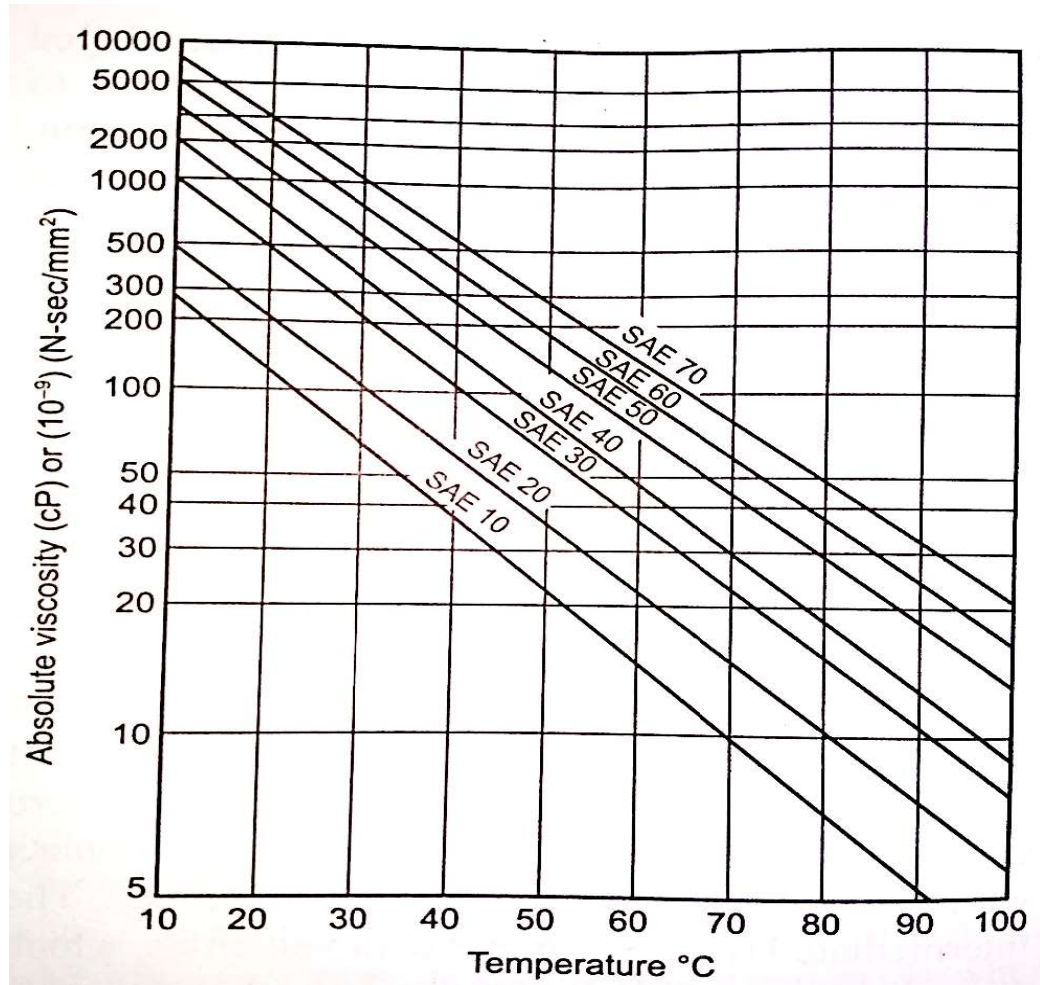
Q.P. 10

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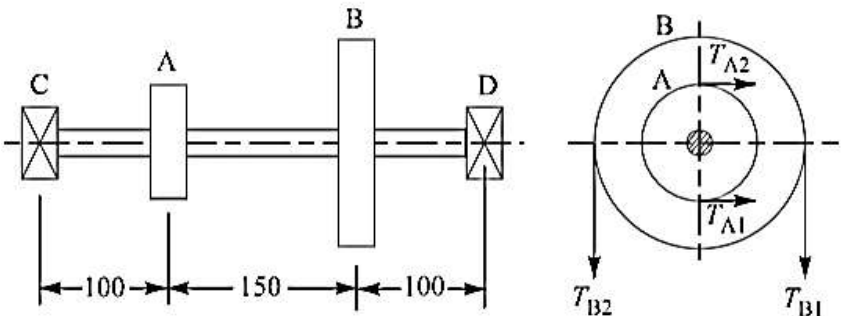
S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	A pressure vessel of the boiler consists of cylindrical shell of 1.6 m inner diameter is subjected to internal steam pressure of 1.5 MPa. Design a suitable longitudinal riveted butt joint which can be used to make the shell. Permissible stresses for rivet and shell in tension, shear and compression are 75, 65 and 110 N/mm ² respectively. Design the joint completely and support with the suitable diagrams.	15	CO3
Q 2	A mild steel shaft has to transmit 10 kW power at 250 rpm with is couple to a machine.. Consider the service factor for design torque (Ct) and appropriate materials for shaft, flange, bolt and key to design the flange coupling. Also draw the diagram of flange coupling designed with all dimensions.	15	CO3
Q 3	A machine shaft, supported on bearings having their centres 750 mm apart, transmitted 185 kW at 600 r.p.m. A gear of 200 mm and 20° tooth profile is located 250 mm to the right of left hand bearing and a 450 mm diameter pulley is mounted at 200 mm to right of right hand bearing. The gear is driven by a pinion with a downward tangential force while the pulley drives a horizontal belt having 180° angle of contact. The pulley weighs 1000 N and tension ratio is 3. Assume the suitable data and design the shaft.	15	CO2/ CO4
Q 4	Two parallel shafts are connected by a pair of spur gear. The pinion transmits 5 KW at 800RPM of the pinion. Both gears are made of different material, If the velocity ratio is 4:1, determine the smallest diameter gears that may be used having sufficient strength without any interference. Assume 20 degree stub teeth. Also check gear in wear and suggest the required BHN for material used for gear.	25	CO4
Q 5	(a)Design a journal bearing for following data used for Reciprocating pump and compressors main bearing application ; Load W= 8 kN Journal speed =2000 rpm Bearing Pressure = 1.8 MPa Assume following : Select Journal diameter or l/d ratio to maintain the pressure as recommended for the application (Reciprocating pump and compressors main bearing), other relevant data (Lubricating oil and operating temperature) and design completely the journal bearing by maintaining the hydrodynamic lubrication conditions. Make the conclusions if any. (b) Select a suitable ball bearing (Angular contact bearing) for the spindle of a drilling machine rotating at 1600 rpm. The bearing is subjected to radial load of 4000N and a thrust	30	CO2/ CO4

load of 3000N. The machine is to work for 12 hours/day for a service life of 5 years. Suggest the diameter of spindle for which bearing can be used.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



Q.P. 11

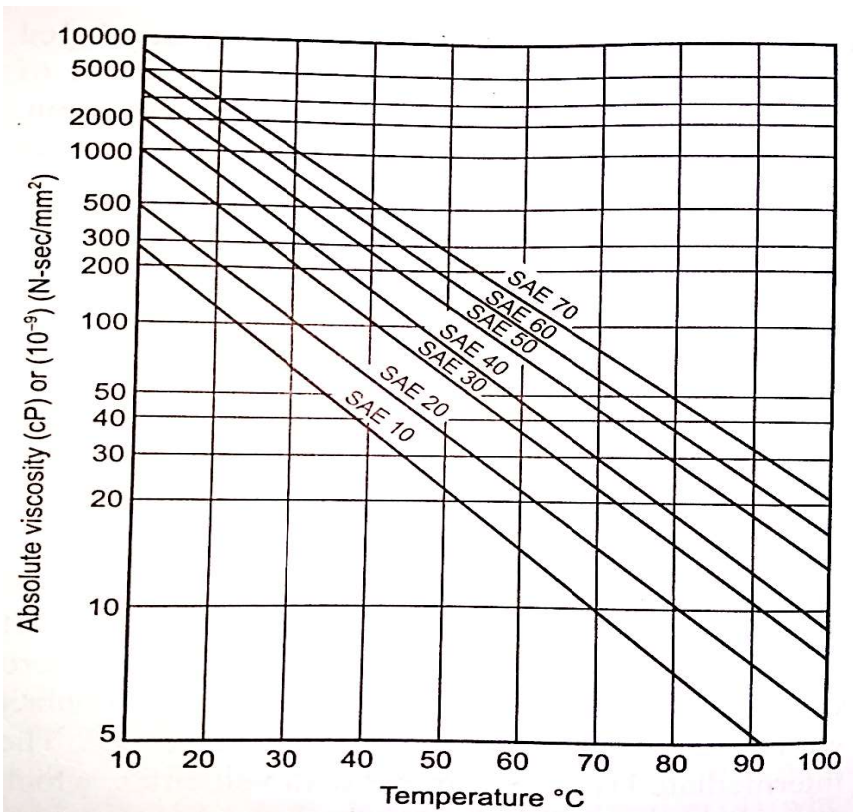
S. No.	Statement of question	Marks	CO																								
SECTION A																											
Q 1	Design a riveted Joint in which the pitch of the rivets in the outer row is twice that in the inner rows. Diameter of boiler shell is 1600 mm and is subjected to internal pressure of 1.7 N/mm^2 . Consider the working stresses as $\sigma_t = 75 \text{ MPa}$ in tension, $\sigma_c = 120 \text{ MPa}$ in compression, and $\tau = 55 \text{ MPa}$ in shear for the joint. Suggest the optimum design.	15	CO3																								
Q 2	Determine the dimension of flange coupling that connect a motor and a pump shaft. The power to be transmitted 8 KW at a shaft speed of 600 rpm. Select suitable material for the parts of the couplings and list the dimensions of designed coupling.	15	CO3																								
Q 3	<p>The shaft, as shown in Fig., is driven by pulley B from an electric motor. Another belt drive from pulley A is running a compressor. The belt tensions for pulley A are 1500 N and 600 N. The ratio of belt tensions for pulley B is 3.5.</p>  <p style="text-align: center;">All dimensions in mm.</p> <p>The diameter of pulley A is 150 mm and the diameter of pulley B is 480 mm. Assume suitable data from DDHB and design the shaft by using ASME code.</p>	15	CO2/ CO4																								
Q 4	<p>Design a pair of spur gear for following data to transmit 10 kW of power available at pinion for speed reduction ratio of 2.5 : 1; Speed of pinion may be considered as 1000 rpm.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Detail</th> <th>Pinion</th> <th>Gear</th> </tr> </thead> <tbody> <tr> <td>Material</td> <td>Semi Steel</td> <td>Cast Iron</td> </tr> <tr> <td>Design Stress</td> <td>84 MPa</td> <td>56 Mpa</td> </tr> <tr> <td>BHN</td> <td>200</td> <td>160</td> </tr> <tr> <td>Speed</td> <td>1600</td> <td>400</td> </tr> <tr> <td>Tooth Profile</td> <td>20°</td> <td>20°</td> </tr> <tr> <td>σ_{en}</td> <td>170 Mpa</td> <td>84 Mpa</td> </tr> <tr> <td>Modulus of Elasticity</td> <td>210 Gpa</td> <td>100 Gpa</td> </tr> </tbody> </table>	Detail	Pinion	Gear	Material	Semi Steel	Cast Iron	Design Stress	84 MPa	56 Mpa	BHN	200	160	Speed	1600	400	Tooth Profile	20°	20°	σ_{en}	170 Mpa	84 Mpa	Modulus of Elasticity	210 Gpa	100 Gpa	25	CO4
Detail	Pinion	Gear																									
Material	Semi Steel	Cast Iron																									
Design Stress	84 MPa	56 Mpa																									
BHN	200	160																									
Speed	1600	400																									
Tooth Profile	20°	20°																									
σ_{en}	170 Mpa	84 Mpa																									
Modulus of Elasticity	210 Gpa	100 Gpa																									

BHN	200	160
Centre distance	200 mm	

Check the gear for dynamic loading and make the conclusions.

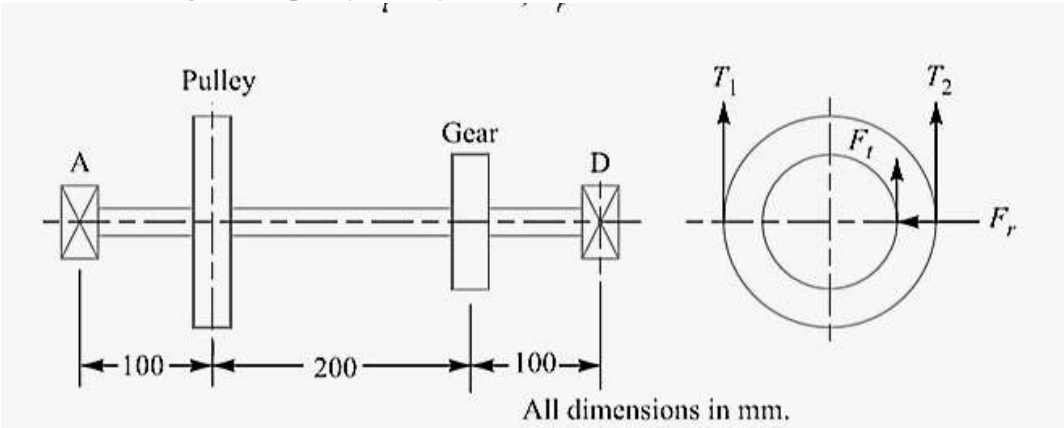
- Q 5
- (a) Suggest the rolling contact bearing (**Deep groove Ball**) for the loading conditions;
- Axial force = 4200 N
- Radial force = 3000 N
- Speed = 1000 rpm
- Desired Life = 8 years by assuming 10 hours working in a day
- Assume the uniform and steady load .Suggest the shaft diameter.
- (b) Suggest the bearing for journal diameter of 80 mm to be used for **Machine tool application**. Load applied to bearing is 15 kN and its speed is 1000 rpm. Consider the bearing pressure as 2.1 N/mm². Select l/d ratio to suggest the suitable journal diameter. Complete the design calculation for bearing. Mention clearly the data assumed in solution; lubricating oil, bearing characteristic numbers etc.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



500060855	R88021701 8	PRASHANT KUMAR
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Q.P. 12

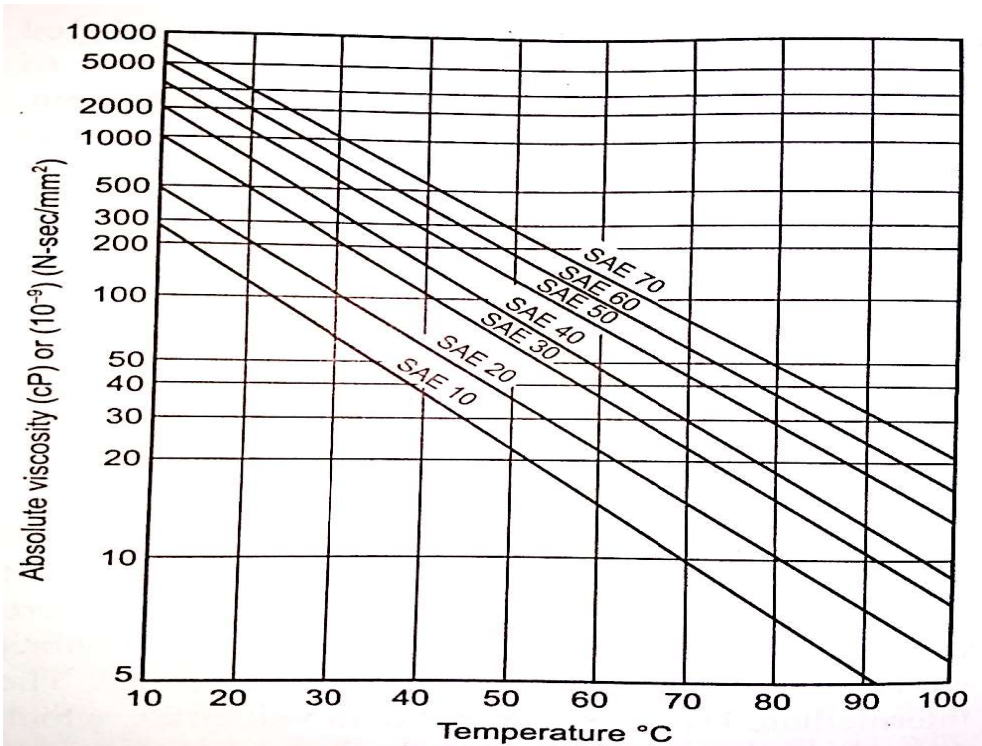
S. No.	Statement of question	Marks	CO																					
SECTION A																								
Q 1	Design a riveted Joint in which the pitch of the rivets in the outer row is twice that in the inner rows. Diameter of boiler shell is 1700 mm and is subjected to internal pressure of 1.9 N/mm^2 . Consider the working stresses as $\sigma_t = 70 \text{ MPa}$ in tension, $\sigma_c = 110 \text{ MPa}$ in compression, and $\tau = 55 \text{ MPa}$ in shear for the joint.	15	CO3																					
Q 2	Determine the dimension of flange coupling that connect a motor and a pump shaft. The power to be transmitted a 8KW at a shaft speed of 1000 rpm. Select suitable material for the components of the couplings and list the dimensions with help of suitable diagram.	15	CO3																					
Q 3	<p>A shaft made of steel receives 7.5 kW power at 1500 r.p.m. A pulley mounted on the shaft as shown in Fig. has ratio of belt tensions 4. The gear forces are as follows : $F_t = 1590 \text{ N}$; $F_r = 580 \text{ N}$. Assume gear and pulley are keyed to the shaft.</p>  <p style="text-align: center;">All dimensions in mm.</p> <p>Design the shaft by ASME code. Select shaft material by using DDHB.</p>	15	CO2/ CO4																					
Q 4	<p>Design a pair of spur gear for following data to transmit 20 kW of power available at pinion for speed reduction ratio of 3: 1; assume speed of pinion as 1200 rpm. Assume the medium speed gear and assume the linear speed of gear in range of 8-10 m/s.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Detail</th> <th>Pinion</th> <th>Gear</th> </tr> </thead> <tbody> <tr> <td>Material</td> <td>Semi Steel</td> <td>Cast Iron</td> </tr> <tr> <td>Design Stress</td> <td>84 MPa</td> <td>56 Mpa</td> </tr> <tr> <td>BHN</td> <td>200</td> <td>160</td> </tr> <tr> <td>Speed</td> <td>1600</td> <td>400</td> </tr> <tr> <td>Tooth Profile</td> <td>20^0</td> <td>20^0</td> </tr> <tr> <td>σ_{en}</td> <td>170 Mpa</td> <td>84 Mpa</td> </tr> </tbody> </table>	Detail	Pinion	Gear	Material	Semi Steel	Cast Iron	Design Stress	84 MPa	56 Mpa	BHN	200	160	Speed	1600	400	Tooth Profile	20^0	20^0	σ_{en}	170 Mpa	84 Mpa	25	CO4
Detail	Pinion	Gear																						
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BHN	200	160																						
Speed	1600	400																						
Tooth Profile	20^0	20^0																						
σ_{en}	170 Mpa	84 Mpa																						

Modulus of Elasticity	210 Gpa	100 Gpa
BHN	200	160

Check the gear for dynamic loading and make the conclusions.

- Q 5
- (c) Suggest the rolling contact bearing (Angular contact bearing Ball) for the loading conditions;
- Axial force = 5000 N
- Radial force = 4000 N
- Speed = 1500 rpm
- Desired Life = 8 years by assuming 8 hours working in a day
- Assume the uniform and steady load .Suggest the shaft diameter.
- (b) Suggest the bearing for journal diameter of 80 mm to be used for **generator application**. Load applied to bearing is 10 kN and its speed is 1000 rpm. Select l/d ratio to suggest the suitable journal diameter. Complete the design calculation for bearing. Mention clearly the data assumed in solution; lubricating oil, bearing characteristic numbers etc..

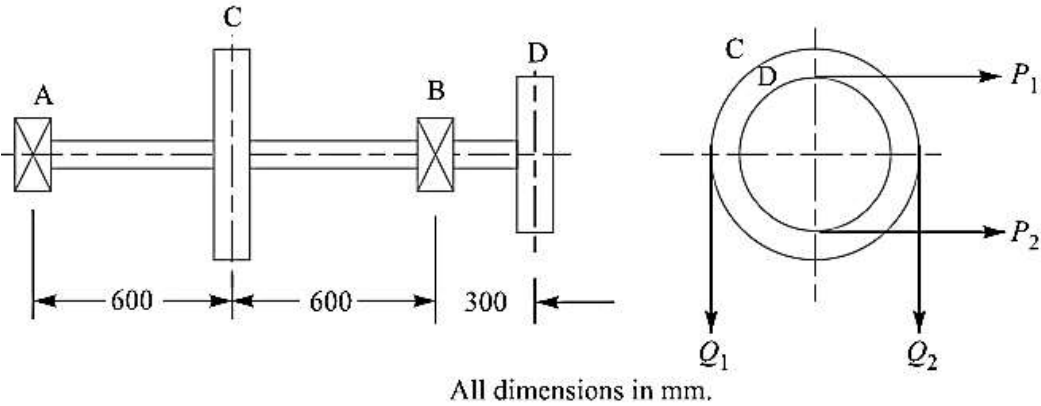
Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



30

CO2/C
O4

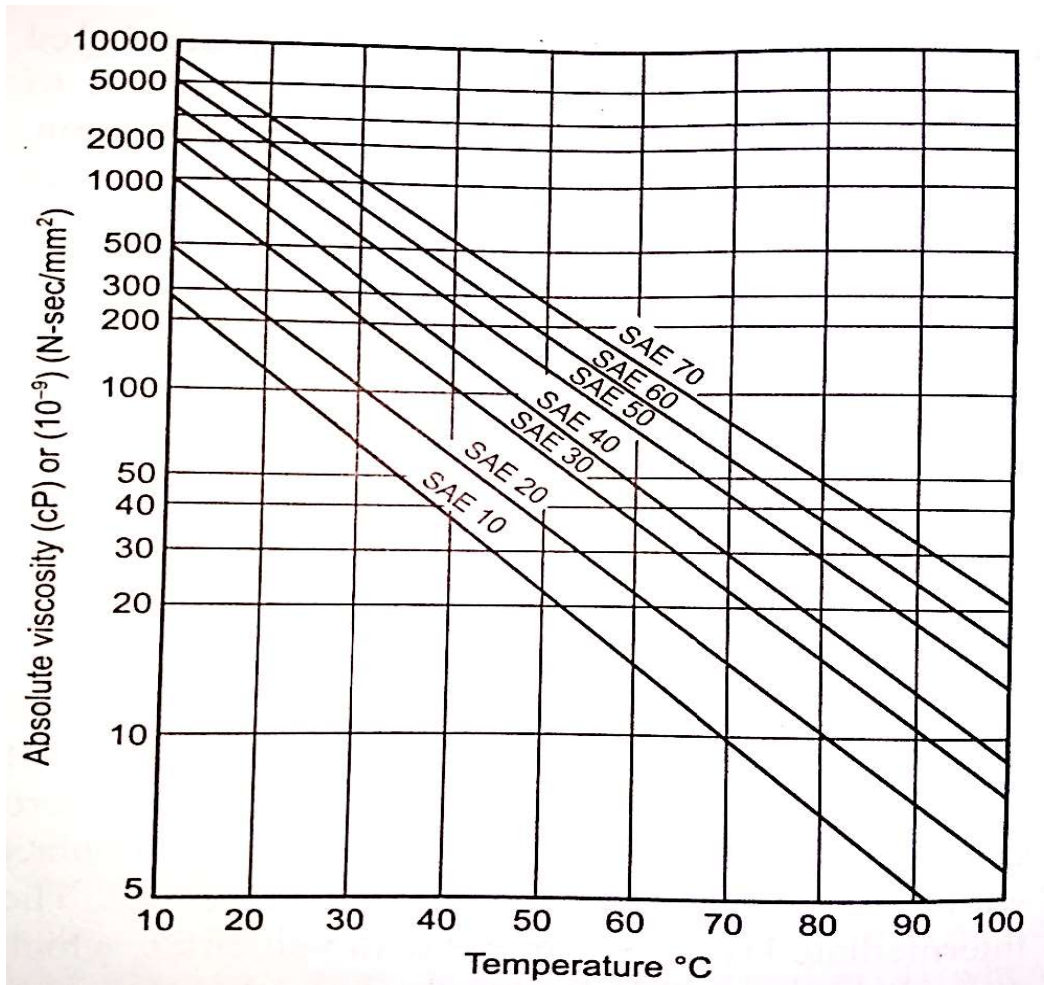
Q.No. 13

S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	Design the longitudinal joint for a 1.25 m diameter steam boiler to carry a steam pressure of 2.5 N/mm ² . The ultimate strength of the boiler plate may be assumed as 420 MPa, crushing strength as 650 MPa and shear strength as 300 MPa. Take the joint efficiency from DDHB Sketch the joint with all the dimensions. Adopt the suitable factor of safety as 5.	15	CO3
Q 2	Design a shaft and flange for a Diesel engine in which protected type of flange coupling is to be adopted for power transmission. The following data is available for design : Power of engine = 75 kW; speed of engine = 200 r.p.m.; maximum torque = 1.25 × mean torque; Assume plain carbon steel for shaft & bolt, CI for flange and mild steel for key. Select material properties from DDHB. Design completely and suggest the diagram.	15	CO3
Q 3	A horizontal shaft AD supported in bearings at A and B and carrying pulleys at C and D is to transmit 30 kW at 600 r.p.m. from drive pulley D to off-take pulley C, as shown in Fig. Calculate the diameter of shaft. The data given is : $P_1 = 3 P_2$ (both horizontal), $Q_1 = 2 Q_2$ (both vertical), radius of pulley C = 200 mm, radius of pulley D = 160 mm. Design the shaft.  <p style="text-align: center;">All dimensions in mm.</p>	15	CO2/ CO4
Q 4	A pair of 20° full-depth involute tooth spur gears is to transmit 6 kW at a speed of 900 r.p.m. of the pinion. The speed reduction ratio is 3: 1. Keep in mind the space limitation in range of 230 mm. Assume suitable different materials for gear & pinion. Design the gear assembly completely. Also check the gear in wear and suggest the suitable BHN.	25	CO4
Q 5	(a) Design a journal bearing for following data used for Railway car axle application : Load W= 8 kN Journal speed =1000 rpm Bearing pressure = 3 N/mm ²	30	CO2/C O4

Assume suitable data (diameter of journal, l/d ratio, lubricating oil, and operating temperature etc) and design completely the journal bearing. Make conclusions if any.

- (b) Select a suitable ball bearing for the head stock of lathe machine rotating at 1200 rpm. The bearing is subjected to radial load of 6000 N and a thrust load of 3000N. The machine is to work for 12 hours/day for a service life of 5 years. Suggest the diameter of spindle for which bearing can be used.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



Q.P. 14

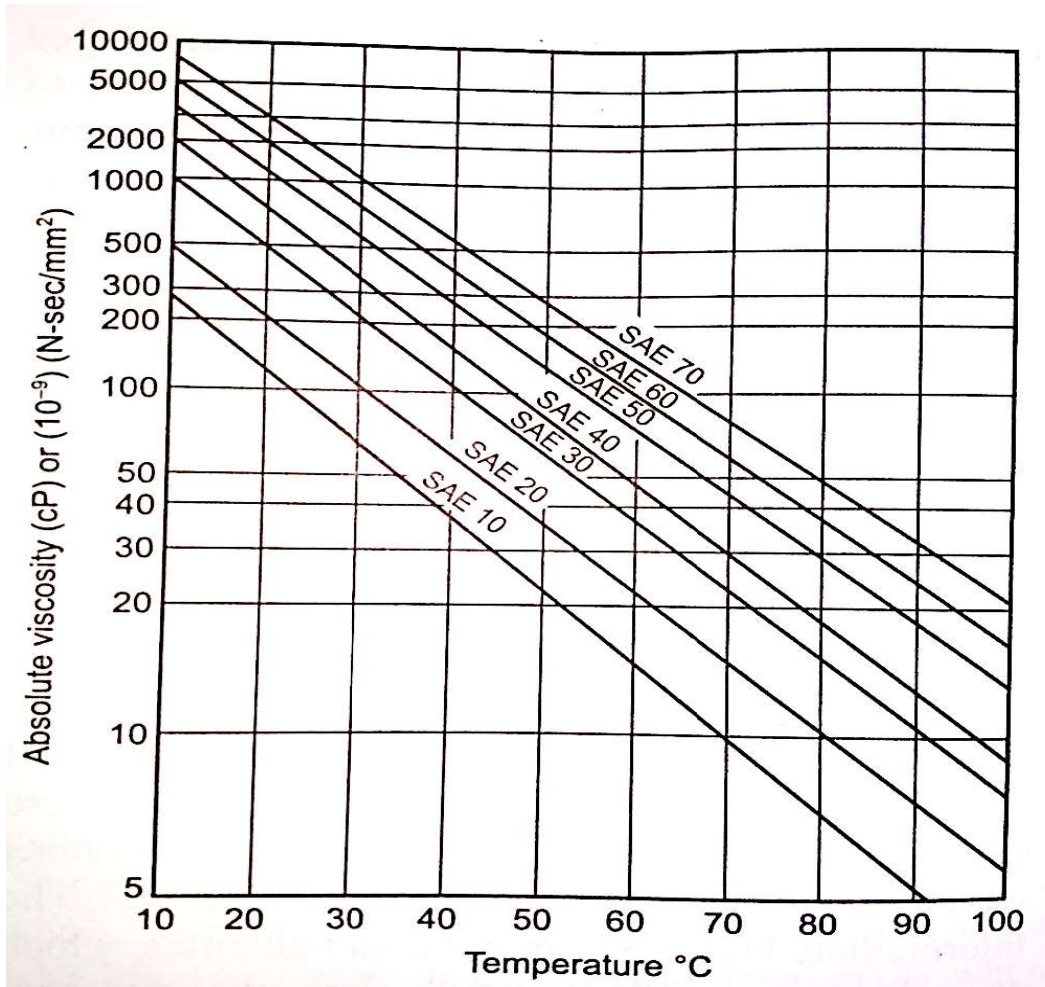
S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	A steam boiler is to be designed for a working pressure of 2.5 N/mm^2 with its inside diameter 1.65 m. Give the design calculations for the longitudinal and circumferential joints for the following working stresses for steel plates and rivets : In tension = 75 MPa ; In shear = 60 MPa; In crushing = 125 MPa. Draw the joints to a suitable scale.	15	CO3
Q 2	The shaft and the flange of a marine engine are to be designed for flange coupling, in which the flange is forged on the end of the shaft. The following particulars are to be considered in the design: Power of the engine = 3 MW Speed of the engine = 100 r.p.m. Permissible shear stress in bolts, shaft and key = 60 MPa Flanges is made up of cast iron FG 150 ($\sigma_{ut} = 150 \text{ MPa}$) . Take factor of safety as 3 for flange. Also draw neat sketch of the coupling.	15	CO3
Q 3	A steel solid shaft transmitting 37.5 kW at 500 r.p.m. is supported on two bearings 750 mm apart and has two gears keyed to it. The pinion having 30 teeth of 5 mm module is located 100 mm to the left of the right hand bearing and delivers power horizontally to the right. The gear having 100 teeth of 5 mm module is located 150 mm to the right of the left hand bearing and receives power in a vertical direction from below, design the shaft as per ASME code.	15	CO2/ CO4
<p style="text-align: center;">All dimensions in mm.</p>			
Q 4	A pair tooth of Spur gear is to transmit 8 kW power at a speed of 800 r.p.m. from pinion to gear for speed reduction ratio of 2: 1 . Assume the suitable data and materials from the design data handbook as required. Assume pitch line velocity in range of 8 to 10 m/sec . Design the gear assembly from static point of view. Also check the gear assembly in wear and suggest the suitable BHN	25	CO4

Q 5

- (a) Suggest the bearing for journal diameter of 100 mm to be used for **Heavy Transmission shafting application**. Load applied to bearing is 20 kN and its speed is 1000 rpm. Complete the design calculation for bearing. Mention clearly the data assumed in solution; lubricating oil, bearing characteristic numbers etc.

- (c) Select a suitable ball bearing for the head stock of lathe machine rotating at 1000 rpm. The bearing is subjected to radial load of 5000N and a thrust load of 2500N. The machine is to work for 10 hours/day for a service life of 6 years. Suggest the diameter of spindle for which bearing can be used.

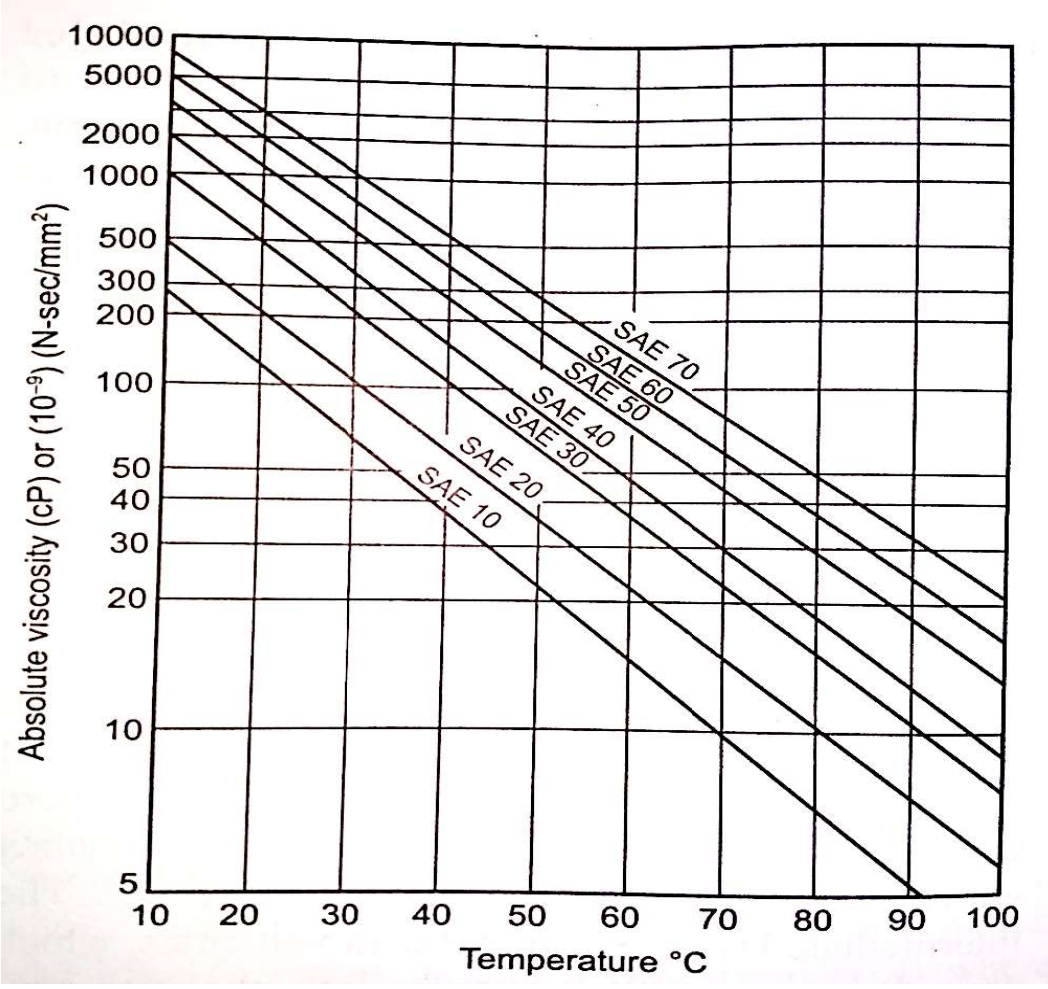
Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



QP 15

S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	<p>Design a longitudinal riveted joint for boiler shell the following data;</p> <p>Diameter of boiler shell = 1700 m Maximum internal pressure = 2N/mm² Strength of plate in tension = 85 MPa Crushing strength of plate = 120 MPa Shearing strength of rivet = 60 MPa Assume the relevant data from DDHB.</p> <p>Select a suitable riveted joint to be designed. Suggest the diagram for designed joint.</p>	15	CO3
Q 2	<p>A protected type flanged coupling is required to transmit 60 kw power at 1440 rpm. Design the coupling with following materials, Material for shaft material for shaft and bolt as 30C and flanges are made up of cast iron FG 200. Take factor of safety as 3 for all components</p>	15	CO3
Q 3	<p>A transmission shaft is supported between two bearings, which are 750 mm apart. Power is supplied to the shaft through a coupling, which is located to the left of the left-hand bearing. Power is transmitted from the shaft by means of a belt pulley, 450 mm in diameter, which is located at a distance of 200 mm to the right of the left-hand bearing. The weight of the pulley is 300 N and the ratio of the belt tension of tight and slack sides is 2:1. The belt tensions act in vertically downward direction. The shaft is made of steel FeE 300 (Syt = 300 N/mm²) and the factor of safety is 3. Determine the shaft diameter, if it transmits 12.5 kW power at 300 rpm from the coupling to the pulley.</p>	15	CO2/ CO4
Q 4	<p>Two parallel shafts are connected by a pair of spur gear. The pinion transmits 5 KW at 600RPM of the pinion. Both gear made of different materials. If the velocity ratio is 3:1, determine the smallest diameter gears that may be used having sufficient strength with 20 degree stub teeth. Also check gear in wear and suggest the required BHN.</p>	25	CO4
Q 5	<p>(a) Select a suitable bearing (with explanation of selection) for an axial flow compressor having a radial load of 2800 N and an axial thrust of 1500 N. Shaft is running at 1000 rpm and the desired life is 22000 hours.</p> <p>(b) Design a journal bearing to be used in a centrifugal pump for radial load on bearing as 15 KN. Assume the suitable values (dia of journal, l/d ratio, lubricating oil , operating temperature etc.) Maintain the hydrodynamic conditions during operation. Also suggest whether cooling is required or not.</p>	30	CO2/ O4

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



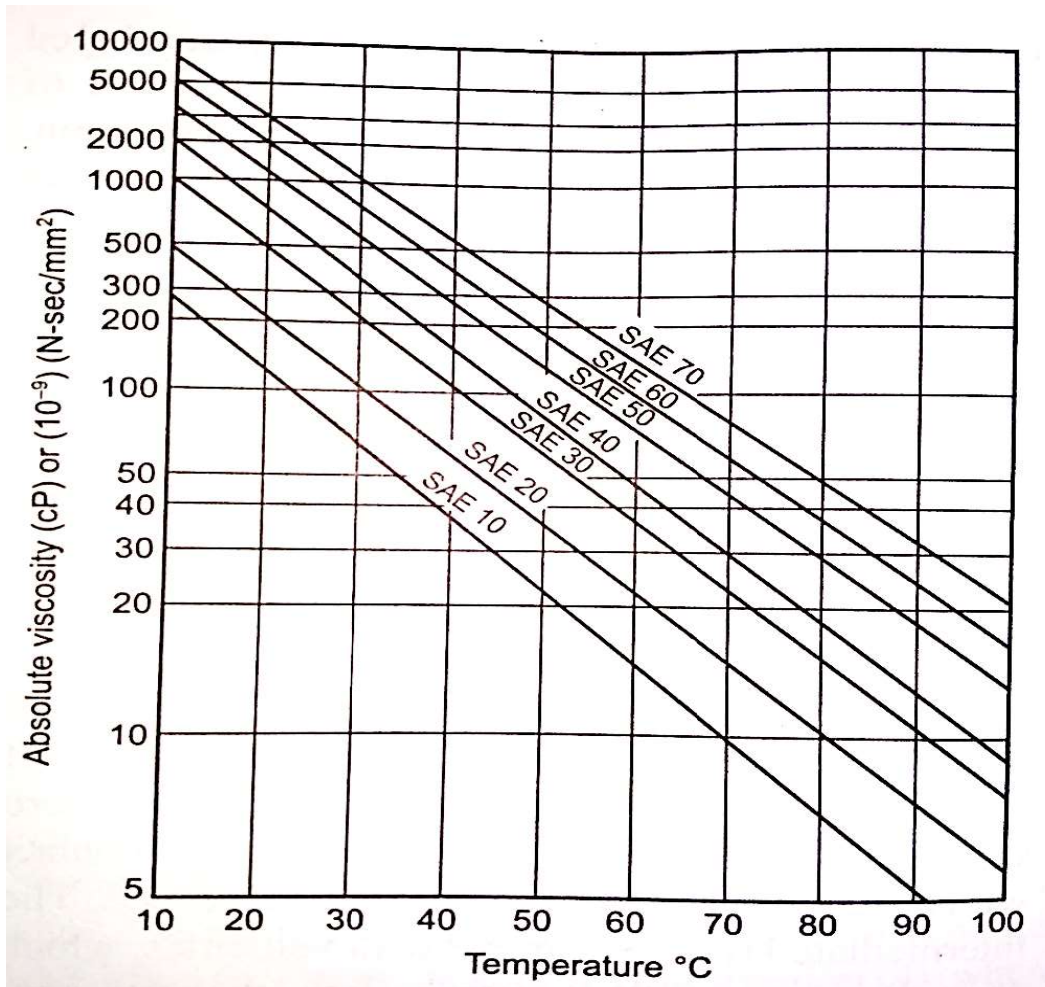
Q.P. No. 16

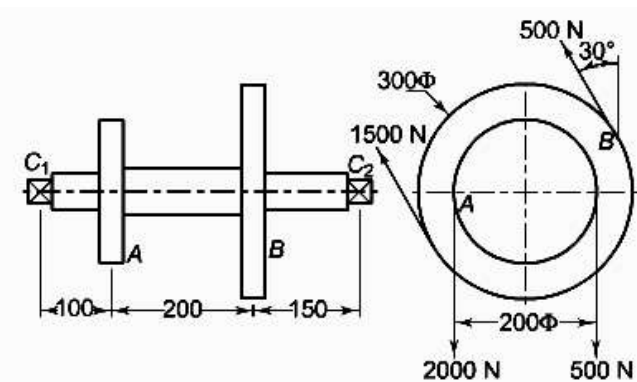
S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	Design a longitudinal riveted joint for boiler shell the following data; Diameter of boiler shell = 1.55 m Maximum internal pressure = 1.9 N/mm ² Strength of plate in tension = 70 MPa Crushing strength of plate = 110 MPa Shearing strength of rivet = 50 MPa Assume the relevant data from DDHB.	15	CO3
Q 2	A protected type flanged coupling is required to transmit 25 kw power at 1500 rpm. Design the coupling after assuming the suitable materials for the components; Shaft, key, flange & bolt. Assume the suitable value of factor of safety and suggest the diagram for designed coupling.	15	CO3
Q 3	A transmission shaft, supporting two pulleys A and B and mounted between two bearings C1 and C2 is shown in Fig.. Power is transmitted from the pulley A to B. The shaft is made of plain carbon steel 45C8 (Sut = 600 and Syt = 380 N/mm ²). The pulleys are keyed to the shaft. Determine the shaft diameter using the ASME code. All dimensions are in mm .	15	CO2/ CO4
Q 4	It is required to design a pair of spur gears with 20° full-depth involute teeth based on the Lewis equation. The velocity factor is to be used to account for dynamic load. The pinion shaft is connected to a 9 kW, 1440 rpm motor. The starting torque of the motor is 150% of the rated torque. The speed reduction is 4 : 1. Consider the materials for pinion as well as the gear and design the gears, specify their dimensions and suggest suitable surface hardness for the gears.	25	CO4

Q 5

- (a) Select an angular contact ball bearing for a radial load of 8000 N and an axial load of 4000 N, operating at a speed of 1000 rpm. For an average life of 4 years at 10 hours per day. Assume uniform and steady load. Suggest the angular contact bearing
- (b) Design a journal bearing for a centrifugal pump from the following data:
Load on the journal = 18 k N, Speed of the journal = 900 rpm. Type of oil is SAE 40. Ambient temperature of oil = 15.5°C.
Assume the operating temperature in range of 55°C to 75°C.
Make the conclusion about the cooling of bearing based upon the calculation.

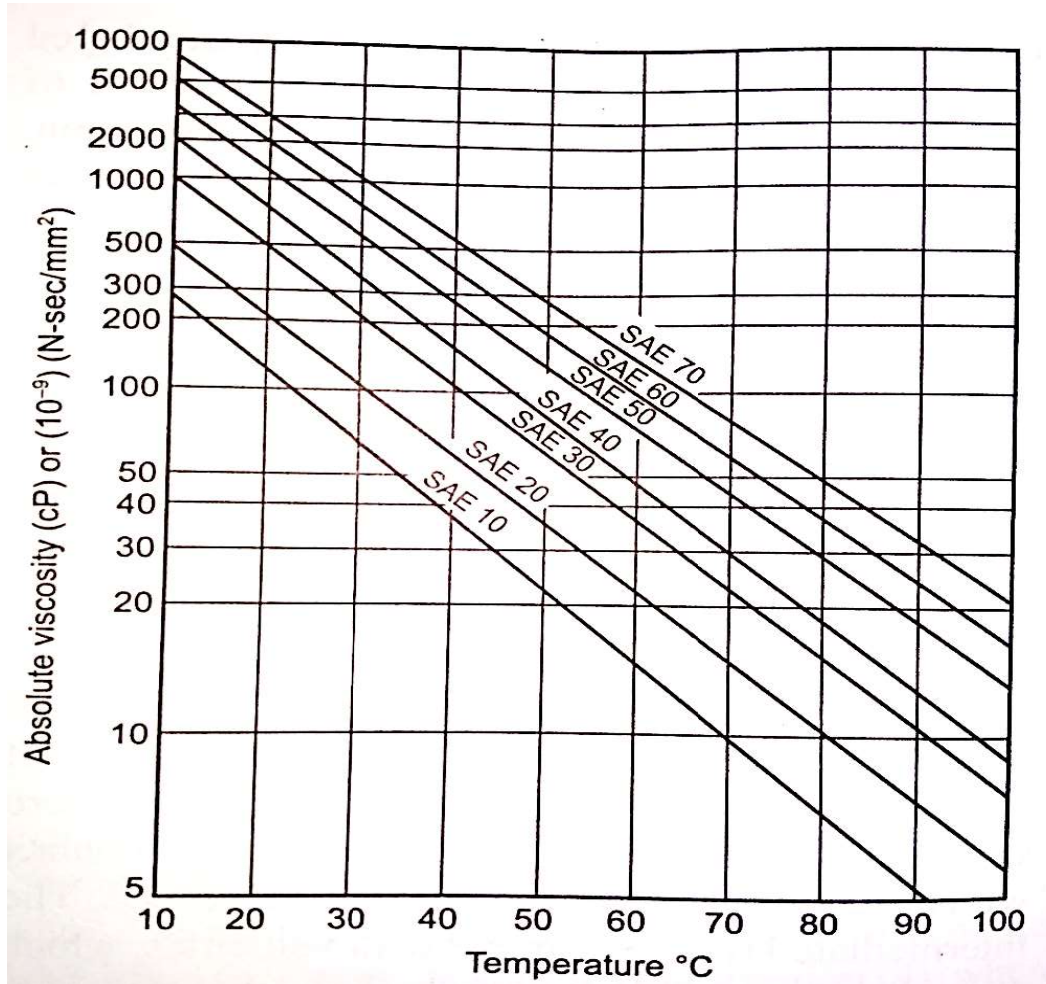
Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	A steam boiler is to be designed for a working pressure of 1.5 N/mm^2 with its inside diameter 1.6 m. Give the design calculations for the longitudinal riveted joints for the following working stresses for steel plates and rivets : In tension = 75 MPa ; In shear = 60 MPa; In crushing = 125 MPa. Select the suitable riveted joint to be designed by using DDHB as recommended by IBR and draw the joints.	15	CO3
Q 2	Design a rigid coupling to transmit 18 kW power at 500 rpm. Design torque may be considered as 120% of the average torque. Shaft , bolts and key are made of plain carbon steel,. Assume that flange is made of CI. Consider material properties and suitable FOS, make design calculation and suggest the diagram.	15	CO3
Q 3	A transmission shaft, supporting two pulleys A and B mounted between two bearings C1 & C2 as shown in figure. Power is transmitted from the pulley A to B. Assume the suitable material of shaft; any grade carbon steel between C40, design the shaft by using ASME codes. Assume that pulleys are keyed to the shaft. Wight of pulleys are 10 kg and 8 kg respectively. Dimensions indicated in diagram are taken in mm. 	15	CO2/ CO4
Q 4	A pair of 20° full-depth involute tooth spur gears is to transmit 10 kW at a speed of 750r.p.m. of the pinion. The speed reduction ratio is 3: 1. Keep in mind the space limitation of 175 mm. Assume suitable different materials for gear & pinion. Design the gear assembly completely. Also check the gear in wear and suggest the suitable BHN.	25	CO4
Q 5	(a) Design a journal bearing for following data used: Load $W = 12 \text{ kN}$ Journal speed = 1000 rpm Assume suitable data (application, lubricating oil, and operating temperature etc) and design completely the journal bearing. Make conclusions if any.	30	CO2/C O4

- (b) Select a suitable ball bearing for the head stock of lathe machine rotating at 1500 rpm. The bearing is subjected to radial load of 6000 N and a thrust load of 3000N. The machine is to work for 10 hours/day for a service life of 6 years. Suggest the diameter of spindle for which bearing can be used.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



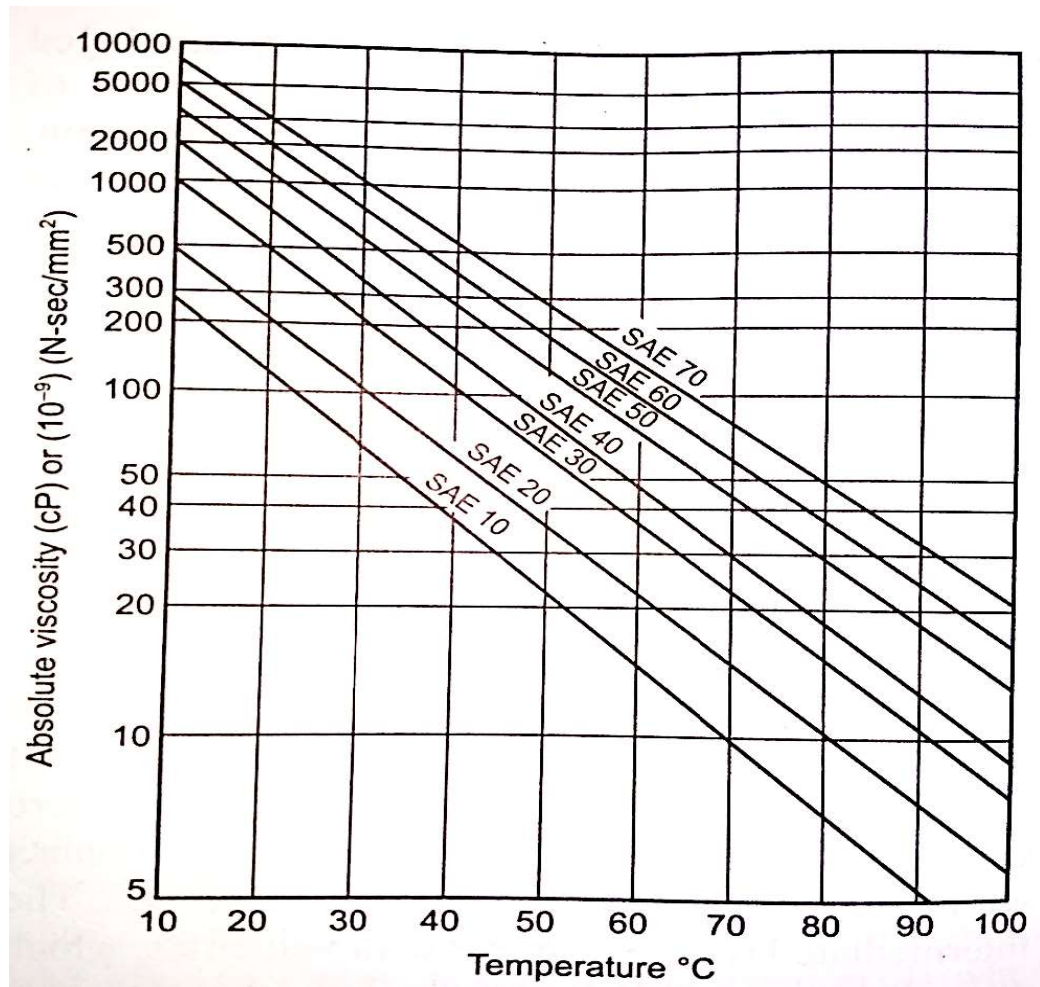
Q.P. 18

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S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	A pressure vessel of the boiler consists of cylindrical shell of 1.8 m inner diameter is subjected to internal steam pressure of 1.75 MPa. Design a suitable longitudinal riveted butt joint which can be used to make the shell. Permissible stresses for rivet and shell in tension, shear and compression are 80, 60 and 120 N/mm ² respectively. Design the joint completely and support with the suitable diagrams.	15	CO3
Q 2	A mild steel shaft has to transmit 25 kW power at 500 rpm with is couple to a machine. Consider the appropriate material for shaft, flange, bolt and key to design the protective type of flange coupling Also draw the diagram of flange coupling designed with all dimensions.	15	CO3
Q 3	A shaft is supported by two bearings which are 1.5 m apart. A 750 mm diameter pulley is fixed at a distance of 400mm to right of left hand bearing, this drives a pulley directly below it with belt drive having max tension 5 kN. Another pulley 500 mm diameter is placed at 500 mm left of right hand bearing which is driven by motor. Consider the angle of wrap 180° and coefficient of friction = 0.3 for belt drive. Assume the suitable data, draw configuration diagram and design the shaft.	15	CO2/ CO4
Q 4	A compressor running at 300 RPM is driven by a 10 KW 1500 RPM Motor through a 20-degree full depth involute gear. The center distance is 190 mm. Select the suitable material for pinion and gear, Design the spur gear drive completely. Assume medium to heavy shock condition and other suitable data if any.	25	CO4
Q 5	(a)Design a journal bearing for following data used for centrifugal pump application ; Load W= 15k N Journal speed =1000 rpm Assume following : Journal diameter or l/d ratio to maintain the pressure as recommended for the application (here centrifugal pump), other relevant data (Lubricating oil and operating temperature) and design completely the journal bearing by maintaining the hydrodynamic lubrication conditions. Make the conclusions if any. (b) Select a suitable ball bearing (Angular contact bearing) for the spindle of a drilling machine rotating at 900 rpm. The bearing is subjected to radial load of 5000N and a thrust	30	CO2/ CO4

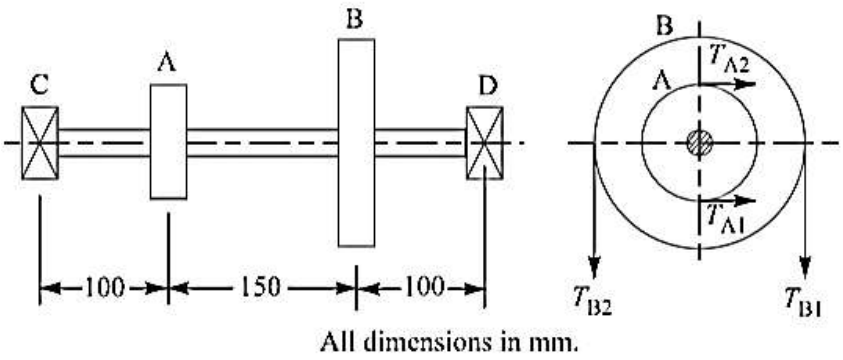
load of 3000N. The machine is to work for 10 hours/day for a service life of 6 years. Suggest the diameter of spindle for which bearing can be used.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



Q.P. 19

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S. No.	Statement of question	Marks	CO																								
SECTION A																											
Q 1	Design a riveted Joint in which the pitch of the rivets in the outer row is twice that in the inner rows. Diameter of boiler shell is 1900 mm and is subjected to internal pressure of 1.95 N/mm^2 . Consider the working stresses as $\sigma_t = 75 \text{ MPa}$ in tension, $\sigma_c = 120 \text{ MPa}$ in compression, and $\tau = 55 \text{ MPa}$ in shear for the joint. Suggest the optimum design.	15	CO3																								
Q 2	Determine the dimension of flange coupling that connect a motor and a pump shaft. The power to be transmitted 22KW at a shaft speed of 1000 rpm. Select suitable material for the parts of the couplings and list the dimensions of designed coupling.	15	CO3																								
Q 3	<p>The shaft, as shown in Fig., is driven by pulley B from an electric motor. Another belt drive from pulley A is running a compressor. The belt tensions for pulley A are 2800 N and 1000 N. The ratio of belt tensions for pulley B is 2.8.</p>  <p style="text-align: center;">All dimensions in mm.</p> <p>The diameter of pulley A is 150 mm and the diameter of pulley B is 450 mm. Assume suitable data from DDHB and design the shaft by using ASME code.</p>	15	CO2/ CO4																								
Q 4	<p>Design a pair of spur gear for following data to transmit 10 kW of power available at pinion for speed reduction ratio of 2.5 : 1; Speed of pinion may be considered as 1000 rpm.</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Detail</th> <th>Pinion</th> <th>Gear</th> </tr> </thead> <tbody> <tr> <td>Material</td> <td>Semi Steel</td> <td>Cast Iron</td> </tr> <tr> <td>Design Stress</td> <td>90 MPa</td> <td>60 Mpa</td> </tr> <tr> <td>BHN</td> <td>250</td> <td>180</td> </tr> <tr> <td>Speed</td> <td>1200</td> <td>600</td> </tr> <tr> <td>Tooth Profile</td> <td>20°</td> <td>20°</td> </tr> <tr> <td>Modulus of Elasticity</td> <td>210 Gpa</td> <td>100 Gpa</td> </tr> <tr> <td>BHN</td> <td>200</td> <td>160</td> </tr> </tbody> </table>	Detail	Pinion	Gear	Material	Semi Steel	Cast Iron	Design Stress	90 MPa	60 Mpa	BHN	250	180	Speed	1200	600	Tooth Profile	20°	20°	Modulus of Elasticity	210 Gpa	100 Gpa	BHN	200	160	25	CO4
Detail	Pinion	Gear																									
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Tooth Profile	20°	20°																									
Modulus of Elasticity	210 Gpa	100 Gpa																									
BHN	200	160																									

Centre distance	225 mm

Check the gear for dynamic loading and make the conclusions.

Q 5 (b) Suggest the rolling contact bearing (**Deep groove Ball**) for the loading conditions;

Axial force = 4800 N

Radial force = 3000 N

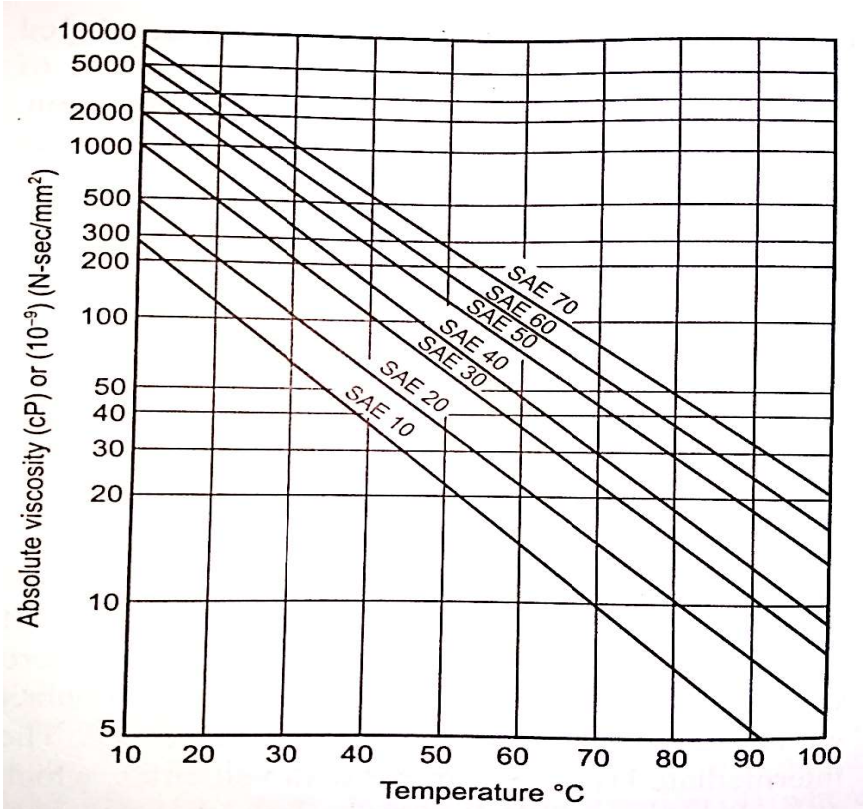
Speed = 1200 rpm

Desired Life = 7 years by assuming 10 hours working in a day

Assume the uniform and steady load .Suggest the shaft diameter.

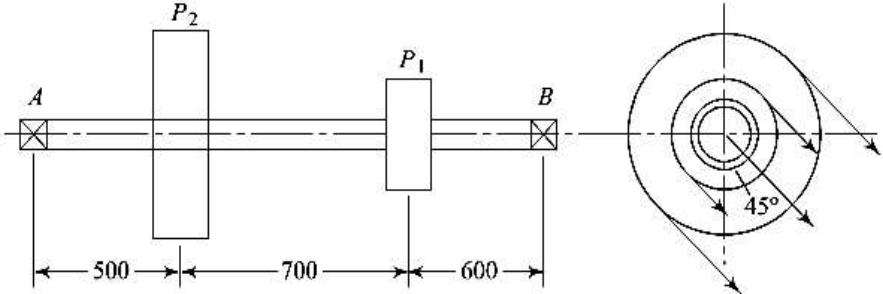
(b) Suggest the bearing for journal diameter of 100 mm to be used for **Machine tool application**. Load applied to bearing is 14 kN and its speed is 1000 rpm. Consider the bearing pressure as 2.1 N/mm². Select l/d ratio to suggest the suitable journal diameter. Complete the design calculation for bearing. Mention clearly the data assumed in solution; lubricating oil, bearing characteristic numbers etc.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



Q.P. 20

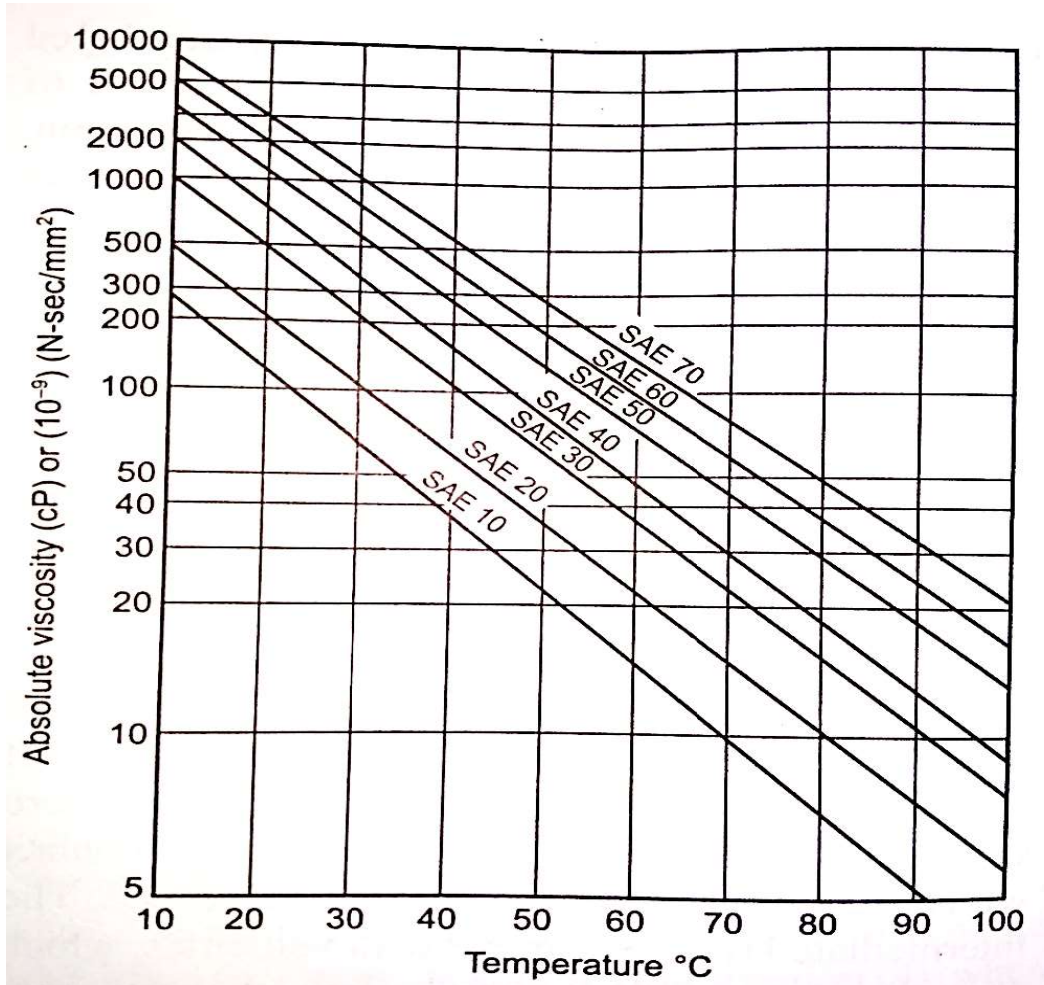
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S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	<p>Design a longitudinal riveted joint for boiler shell the following data;</p> <p>Diameter of boiler shell = 1600 m Maximum internal pressure = 2.5 N/mm² Strength of plate in tension = 84 MPa Crushing strength of plate = 130 MPa Shearing strength of rivet = 70 MPa Assume the relevant data from DDHB.</p> <p>Select a suitable riveted joint to be designed. Suggest the diagram for designed joint.</p>	15	CO3
Q 2	<p>A rigid coupling transmits 20 kW at 180 rpm. The service factor for the application is 1.2 (take design torque as 1.2 times the mean torque). Select the suitable material for the various parts of the coupling. Take factor of safety as 3 for all components. Also draw neat sketch of the coupling.</p>	15	CO3
Q 3	<p>Design a line shaft transmitting power to two machine tools. The power received by the shaft is 20kW at 500 rpm. The diameter of pulley P₁ is 200 mm and its mass is 40 kg. The diameter and mass of pulley P₂ are 400 mm and 75 kg respectively. Assume the belt tension ratio of 2.5 for both pulleys, design the shaft as per ASME code. Select required data</p>  <p>All the dimensions are in mm.</p>	15	CO2/ CO4
Q 4	<p>A pair tooth of spur gear is to transmit 6 kW power at a speed of 1500 r.p.m. from pinion to gear for speed reduction ratio of 3:1. Assume the suitable data and materials from the design data handbook as required.</p> <p>Design the gear assembly from static point of view. Also check the gear assembly in wear and suggest the suitable BHN</p>	25	CO4
Q 5	<p>(a) Suggest the bearing to be used for Machine tool application. Load applied to bearing is 10 kN and its speed is 1000 rpm. Complete the design calculation for bearing.</p>	30	CO2/C O4

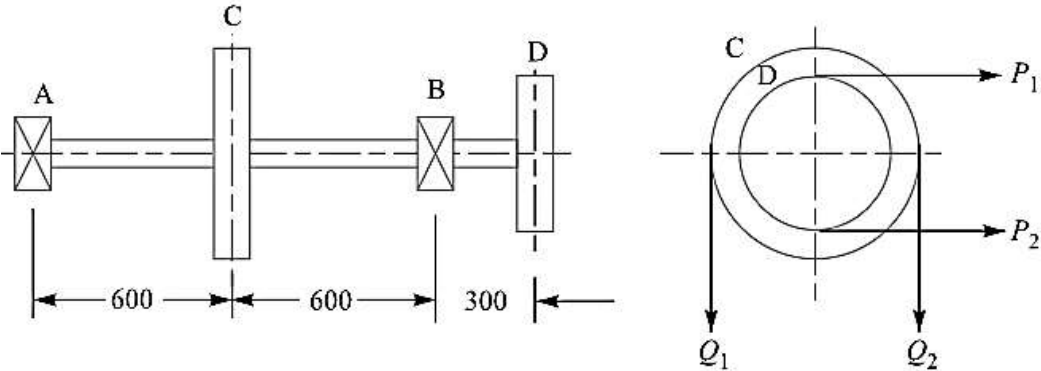
Mention clearly the data assumed in solution; lubricating oil, bearing pressure, l/d ratio etc.

- (b) Select a suitable ball bearing for the head stock of lathe machine rotating at 1500 rpm. The bearing is subjected to radial load of 4800 and a thrust load of 3200N. The machine is to work for 12 hours/day for a service life of 6 years. Suggest the diameter of spindle for which bearing can be used.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



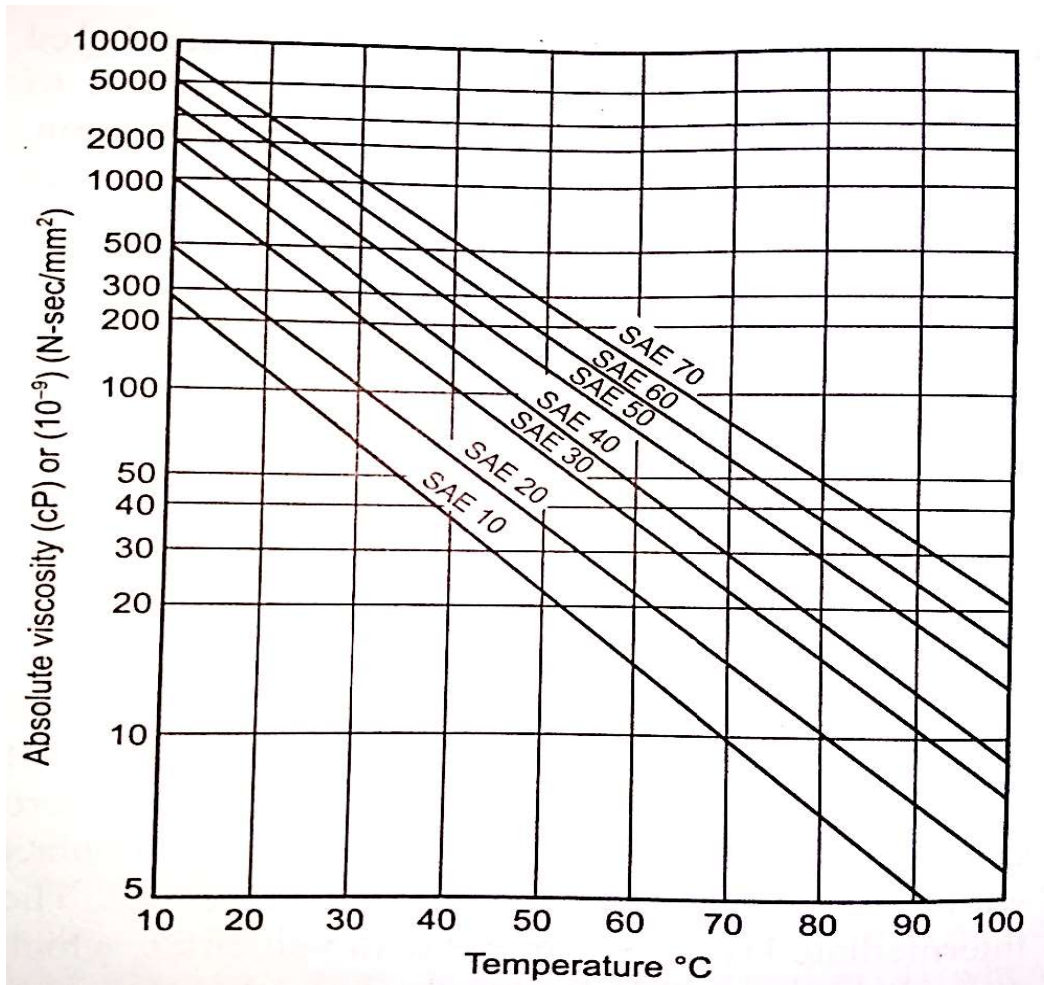
Q.No. 21

S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	Design the longitudinal joint for a 1.45 m diameter steam boiler to carry a steam pressure of 2.5 N/mm ² . The allowable stress in tension for boiler plate may be assumed as 80 MPa, crushing stress as 125 MPa and shear stress as 55 MPa. Take the joint efficiency from DDHB Sketch the joint with all the dimensions.	15	CO3
Q 2	Design a shaft and flange for a Diesel engine in which protected type of flange coupling is to be adopted for power transmission. The following data is available for design : Power of engine = 50 kW; speed of engine = 500 r.p.m.; maximum torque = 1.25 × mean torque; Assume plain carbon steel for shaft & bolt, CI for flange and mild steel for key. Select material properties from DDHB. Design completely and suggest the diagram.	15	CO3
Q 3	A horizontal shaft AD supported in bearings at A and B and carrying pulleys at C and D is to transmit 15 kW at 600 r.p.m. from drive pulley D to off-take pulley C, as shown in Fig. Calculate the diameter of shaft. The data given is : $P_1 = 2.5 P_2$ (both horizontal), $Q_1 = 2 Q_2$ (both vertical), radius of pulley C = 200 mm, radius of pulley D = 160 mm. Design the shaft. Weight of pulley C and D may be assumed as 200 N and 100 N respectively.	15	CO2/ CO4
 <p style="text-align: center;">All dimensions in mm.</p>			
Q 4	A pair of 20° stub teeth involute tooth spur gears is to transmit 10kW available at pinion rotating with 800 rpm.. The speed reduction ratio is 4: 1. Keep in mind the space limitation (Max. 200 mm). Assume suitable different materials for gear & pinion. Design the gear assembly completely. Also check the gear in wear and suggest the suitable BHN.	25	CO4
Q 5	(a) Design a journal bearing for following data used for Railway car axle application : Load W= 12 kN Journal speed =1000 rpm Bearing pressure = 3 N/mm ²	30	CO2/C O4

Assume suitable data (diameter of journal, l/d ratio, lubricating oil, and operating temperature etc) and design completely the journal bearing. Make conclusions if any.

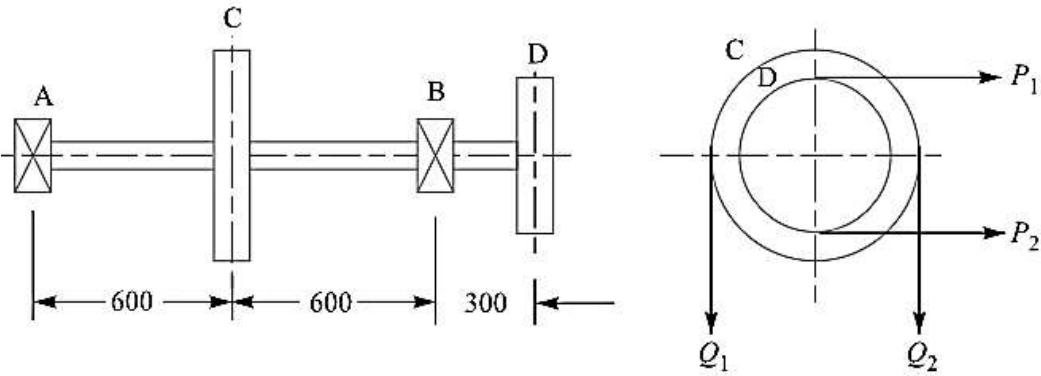
- (b) Select a suitable ball bearing for the head stock of lathe machine rotating at 1000 rpm. The bearing is subjected to radial load of 6500 N and a thrust load of 3200N. The machine is to work for 12 hours/day for a service life of 5 years. Suggest the diameter of spindle for which bearing can be used.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



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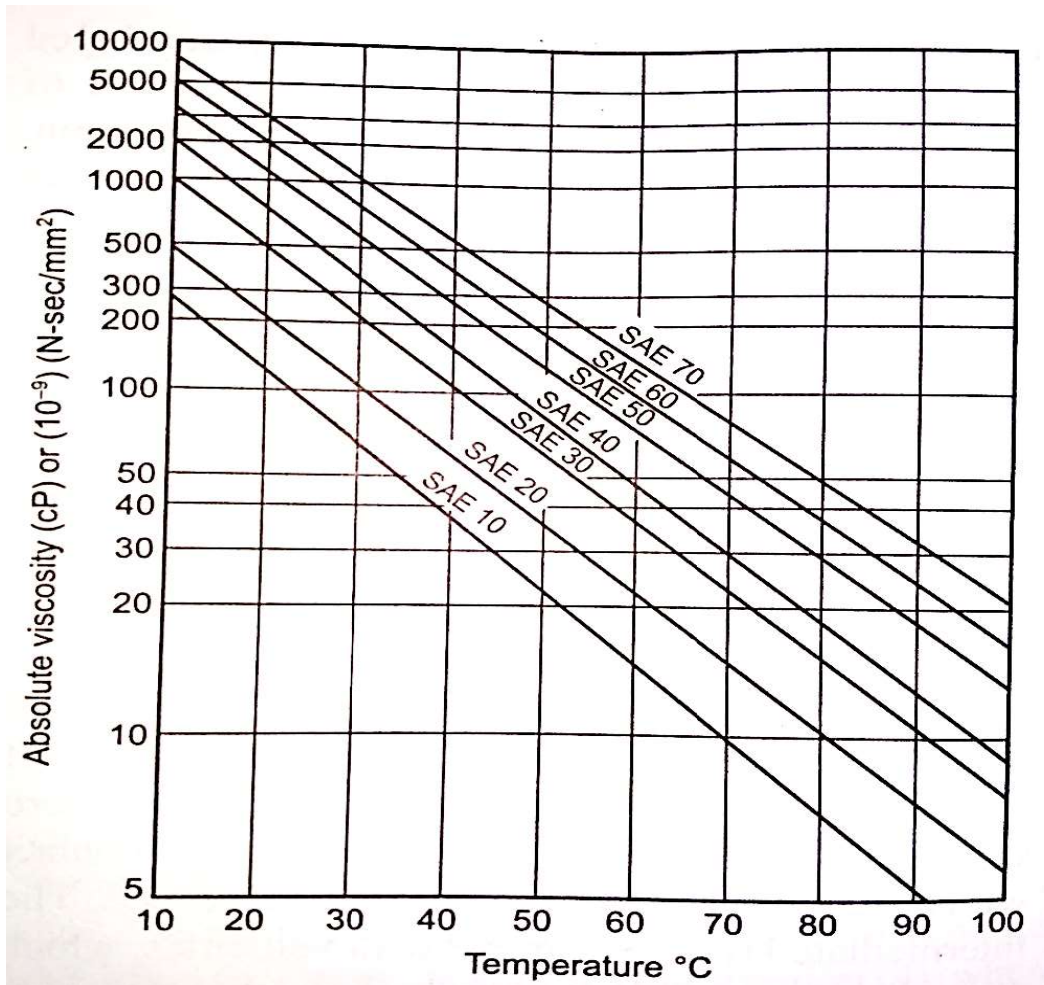
Q.No. 22

S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	Design the longitudinal joint for a 1.6 m diameter steam boiler to carry a steam pressure of 2.4 N/mm ² . The allowable stress in tension for boiler plate may be assumed as 80 MPa, crushing stress as 125 MPa and shear stress as 55 MPa. Take the joint efficiency from DDHB Sketch the joint with all the dimensions.	15	CO3
Q 2	Design a shaft and flange for a Diesel engine in which protected type of flange coupling is to be adopted for power transmission. The following data is available for design : Power of engine = 30 kW; speed of engine = 600 r.p.m.; maximum torque = 1.5 × mean torque; Assume plain carbon steel for shaft & bolt, CI for flange and mild steel for key. Select material properties from DDHB. Design completely and suggest the diagram.	15	CO3
Q 3	A horizontal shaft AD supported in bearings at A and B and carrying pulleys at C and D is to transmit 12 kW at 600 r.p.m. from drive pulley D to off-take pulley C, as shown in Fig. Calculate the diameter of shaft. The data given is : $P_1 = 2.25 P_2$ (both horizontal), $Q_1 = 2.5 Q_2$ (both vertical), radius of pulley C = 200 mm, radius of pulley D = 160 mm. Design the shaft. Weight of pulley C and D may be assumed as 400 N and 200 N respectively.	15	CO2/ CO4
	 <p style="text-align: center;">All dimensions in mm.</p>		
Q 4	A pair of 14 1/2 ° full depth involute tooth spur gears is to transmit 5 kW available at pinion rotating with 750 rpm.. The speed reduction ratio is 2.5: 1. Keep in mind the space limitation (Max. 150 mm). Assume suitable different materials for gear & pinion. Design the gear assembly completely. Also check the gear in wear and suggest the suitable BHN.	25	CO4
Q 5	(a) Design a journal bearing for following data used for Machine Tool application : Load W= 12 kN Journal speed =1000 rpm	30	CO2/C O4

Assume suitable data (diameter of journal, l/d ratio, lubricating oil, and operating temperature etc) and design completely the journal bearing. Make conclusions if any.

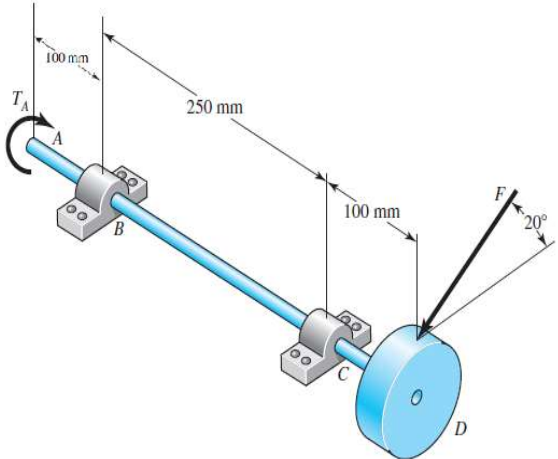
- (b) Select a suitable ball bearing for the head stock of lathe machine rotating at 1000 rpm. The bearing is subjected to radial load of 7000 N and a thrust load of 3500N. The machine is to work for 6 hours/day for a service life of 8 years. Suggest the diameter of spindle for which bearing can be used.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5



Q.P. 23

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S. No.	Statement of question	Marks	CO
SECTION A			
Q 1	A pressure vessel of the boiler consists of cylindrical shell of 1.6 m inner diameter is subjected to internal steam pressure of 1.5 MPa. Design a suitable longitudinal riveted butt joint which can be used to make the shell. Permissible stresses for rivet and shell in tension, shear and compression are 75, 65 and 110 N/mm ² respectively. Design the joint completely and support with the suitable diagrams.	15	CO3
Q 2	A mild steel shaft has to transmit 15 kW power at 500 rpm with is coupled to a machine.. Consider the service factor for design torque (Ct) and appropriate materials for shaft, flange, bolt and key to design the flange coupling. Also draw the diagram of flange coupling designed with all dimensions.	15	CO3
Q 3	The rotating shaft is simply supported by bearings at points B and C and is driven by a gear (not shown) which meshes with the spur gear at D, which has a 250 mm pitch diameter. Consider the mass of gear as 10 kg. The force F from the drive gear acts at a pressure angle of 20°. The shaft transmits a torque to point A of T _A = 1000 Nm. Using a factor of safety of 4, determine diameter of the shaft. Consider appropriate material of the shaft.	15	CO2/ CO4
 <p style="text-align: center;">All the dimensions are in mm.</p>			
Q 4	Two parallel shafts are connected by a pair of spur gear. The pinion transmits 9 KW at 900RPM of the pinion. Both gears are made of same material, If the velocity ratio is 3:1, determine the smallest diameter gears that may be used having sufficient strength without any interference. Assume 20 degree stub teeth. Solve by using pitch line velocity between 8-10 m/sec. Also check gear in wear and suggest the required BHN for material used for gear.	25	CO4
Q 5	(a)Design a journal bearing for following data used for Reciprocating pump and compressors main bearing application ;	30	CO2/ CO4

Load $W = 9 \text{ kN}$

Journal speed = 1200 rpm

Assume following :

Select Journal diameter or l/d ratio to maintain the pressure as recommended for the application (**Reciprocating pump and compressors main bearing**), other relevant data (Lubricating oil and operating temperature) and design completely the journal bearing by maintaining the hydrodynamic lubrication conditions. Make the conclusions if any.

(b) Select a suitable ball bearing (**Angular contact bearing**) for the spindle of a drilling machine rotating at 1500 rpm. The bearing is subjected to radial load of 3500N and a thrust load of 2500 N. The machine is to work for 10 hours/day for a service life of 7 years. Suggest the diameter of spindle for which bearing can be used.

Fig : Viscosity Vs Temperature Diagram for Lubricating Oils (Journal Bearing)
Q.No.5

