JEPPIAAR ENGINEERING COLLEGE

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

VI SEMESTER

ME6601 – Design of Transmission Systems

JEPPIAAR ENGINEERING COLLEGE

Vision of Institution

To build Jeppiaar Engineering College as an institution of academic excellence in technological and management education to become a world class university.

Mission of Institution

- To excel in teaching and learning, research and innovation by promoting the principles of scientific analysis and creative thinking.
- To participate in the production, development and dissemination of knowledge and interact with national and international communities.
- To equip students with values, ethics and life skills needed to enrich their lives and enable them to meaningfully contribute to the progress of society.
- To prepare students for higher studies and lifelong learning, enrich them with the practical and entrepreneurial skills necessary to excel as future professionals and contribute to Nation's economy.

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

JEPPIAAR ENGINEERING COLLEGE

DEPARTMENT OF MECHANICAL ENGINEERING

Vision of the Department

To create excellent professionals in the field of Mechanical Engineering and to uplift the quality of technical education on par with the International Standards.

Department Mission

1. **To reinforce** the fundamentals of Science and Mathematics to Mechanical Engineering **and critically and relatively investigate co**mplex mechanical systems and processes.
2. To engage in the **production, expansion and practice** of advanced engineering applications through knowledge sharing activities by interacting with global communities and industries.
3. To **equip** students with **engineering ethics, professional roles, corporate social responsibility** and life skills and **apply** them for the betterment of society.
4. **To promote** higher studies and lifelong learning and entrepreneurial skills and **develop** excellent professionals for empowering nation's economy.

PEO's

1. To **enrich** the technical knowledge of design, manufacturing and management of mechanical systems and **develop creative and analytical thinking** in research.
2. To **relate, strengthen and develop** the theoretical knowledge of the Mechanical Engineering by exhibiting various concepts applied through diverse industrial exposures and experts' guidance.
3. **Facilitate** the students to communicate effectively on complex social, professional and engineering activities with strict adherence to ethical principles.
4. **Create awareness for independent and life long learning and develop the ability to keep abreast of modern trends and adopt them for personal technological growth of the nation.**

PSO's

1. To understand the basic concept of various mechanical engineering field such as design, manufacturing, thermal and industrial engineering.
2. To apply the knowledge in advanced mechanical system and processes by using design and analysis techniques.
3. To develop student's professional skills to meet the industry requirements and entrepreneurial skills for improving nation's economy stronger.

ME6601- DESIGN OF TRANSMISSION SYSTEMS

COURSE OUTCOMES

C310.1	Illustrate the principles and procedure to develop and analyze the Mechanical Power Transmission Drives
C310.2	Categorize the parallel shafts and non parallel shafts problem and design through standard procedure
C310.3	Classify the shaft drive arrangement and analyze by constructing through standard procedure
C310.4	Design and evaluate the component parameters for obtaining various speeds and strength requirements
C310.5	Design and analyse the various stresses produced in the automobile parts

ME6601 DESIGN OF TRANSMISSION SYSTEMS L T P C
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OBJECTIVES:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements
- To learn to use standard data and catalogues
  (Use of P S G Design Data Book permitted)

UNIT I DESIGN OF FLEXIBLE ELEMENTS 9

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 9

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

UNIT III BEVEL, WORM AND CROSS HELICAL GEARS 9

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth.
Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT IV GEAR BOXES 9

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

UNIT V CAMS, CLUTCHES AND BRAKES 9

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches-Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to successfully design transmission components used in Engine and machines

TEXT BOOKS:

1. Bhandari V, “Design of Machine Elements”, 3rd Edition, Tata McGraw-Hill Book Co, 2010.

2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 8th Edition, Tata McGraw-Hill, 2008.

REFERENCES:

1. Sundararajamoorthy T. V, Shanmugam .N, “Machine Design”, Anuradha Publications, Chennai, 2003.
2. Gitin Maitra, L. Prasad “Hand book of Mechanical Design”, 2nd Edition, Tata McGraw-Hill, 2001.
3. Prabhu. T.J., “Design of Transmission Elements”, Mani Offset, Chennai, 2000.
4. C.S.Sharma, Kamlesh Purohit, “Design of Machine Elements”, Prentice Hall of India, Pvt. Ltd., 2003.
5. Bernard Hamrock, Steven Schmid, Bo Jacobson, “Fundamentals of Machine Elements”, 2nd Edition, Tata McGraw-Hill Book Co., 2006.
6. Robert C. Juvinall and Kurt M. Marshek, “Fundamentals of Machine Design”, 4th Edition, Wiley, 2005
7. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill BookCo.(Schaum’s Outline), 2010
8. Orthwein W, “Machine Component Design”, Jaico Publishing Co, 2003.
9. Ansel Ugural, “Mechanical Design – An Integral Approach", 1st Edition, Tata McGraw-Hill Book Co, 2003.
10. Merhyle F. Spotts, Terry E. Shoup and Lee E. Hornberger, “Design of Machine Elements” 8th Edition, Printice Hall, 2003.
11. U.C.Jindal : Machine Design, "Design of Transmission System", Dorling Kindersley, 2010

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DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

SUBJECT : ME6601 – Design of Transmission Systems

YEAR /SEM: III /VI

UNIT I DESIGN OF FLEXIBLE ELEMENTS

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

PART – A

CO Mapping : CO310.1

Q.No	Questions	BT Level	Competence	PO
1	Why are idler pulleys used in a belt drive?	BTL-1	Remembering	PO1
2	When do you use stepped pulley drive?	BTL-1	Remembering	PO1
3	Explain the term crowning of pulleys.	BTL-2	Understanding	PO1
4	Explain the law of belting.	BTL-2	Understanding	PO1
5	What is meant by ply in a flat belt?	BTL-1	Remembering	PO1
6	What is centrifugal effect on belts?	BTL-1	Remembering	PO1
7	What are the losses in belt drives?	BTL-1	Remembering	PO1
8	Why a longer belt will last more than a shorter belt?	BTL-1	Remembering	PO1
9	What is wipping? How it can be avoided in belt drives?	BTL-1	Remembering	PO1
10	Explain reasons for V-belt drive being preferred to flat belt drive?	BTL-2	Understanding	PO2,PO3
11	How will you determine the number of belts required in the design of V-belt drives?	BTL-1	Remembering	PO2,PO3
12	When do you prefer a chain drive to a belt or rope drive?	BTL-1	Remembering	PO5,PO6
13	What are the different types of chains?	BTL-1	Remembering	PO1
14	What are the applications of link (or hoisting) chains?	BTL-1	Remembering	PO1
15	What is chordal action in chain drives?	BTL-1	Remembering	PO1
16	Why in chain drives, the sprocket has odd number of teeth and the chain has even number of links?	BTL-1	Remembering	PO3,PO4
17	What is a silent chain? In what situations, silent chains are preferred?	BTL-1	Remembering	PO1,PO2,PO3
18	What are the possible ways by which a chain drive may fail?	BTL-1	Remembering	PO1
19	Explain creep in belts.	BTL-2	Understanding	PO1
20	In what ways, timing belts are superior to ordinary V-belts?	BTL-2	Understanding	PO1,PO2,PO4
21	What is belt rating?	BTL-1	Remembering	PO1
22	classify the materials for belts.	BTL-4	Analyzing	PO1
23	How is wire-ropes designated?	BTL-1	Remembering	PO1,PO2,PO3
24	What are the various stresses induced in wire ropes?	BTL-1	Remembering	PO1
25	List the applications of chain drives.	BTL-4	Analyzing	PO1
26	What are the advantages of chain drives?	BTL-1	Remembering	PO1
27	List some drawbacks of chain drives.	BTL-4	Analyzing	PO1

Q.No	Questions	BT Level	Competence	PO
28	What is a power drive? Mention their types	BTL-1	Remembering	PO1
29	What are the factors on which the coefficient of friction between the belt and pulley depends?	BTL-1	Remembering	PO1,PO3,PO4
30	In what ways wire ropes are superior to fiber ropes?	BTL-2	Understanding	PO1,PO3,PO5
	PART – B & C			
1	Design a V-belt drive and calculate average stress induced in the belt for the following specifications: Power to be transmitted 45 KW, Speed of driving wheel 1400 rpm, speed reduction factor is 3. Service 16 hours/ day.	BTL-6	Creating	PO1,PO2,PO3, PO7, PO8, PO12
2	Design a V-belt drive and calculate the actual belt tension and average stress for the following data. Driven pulley diameter, D= 300 mm, driver pulley diameter, d=150 mm, speed N1 = 1400 rpm, N2 = 400 rpm and power, P = 75 kW.	BTL-6	Creating	PO1,PO2,PO3, PO7, PO8, PO12
3	Design a chain drive to actuate a compressor from 15KW electric motor running at 1000rpm, the compressor speed being 350 rpm. The minimum centre distance is 500 mm. the compressor operates 15 hours/day. The chain tension may be adjusted by shifting the motor.	BTL-6	Creating	PO1,PO2,PO3, PO7, PO8, PO12
4	A 7.5 KW electric motor running at 1400 rpm is used to drive the input shaft of the gear box of a machine. Design a suitable roller chain to connect the motor shaft to the gear box shaft to give an exact speed ratio of 10:1. The center distance is 600 mm.	BTL-6	Creating	PO1,PO2,PO3, PO7, PO8, PO12
5	A belt is to transmit 25 KW at 720 rpm to a rolling machine with a speed ratio of 3. Centre distance between the pulleys is 2.8 m. Design a suitable belt drive if the rolling machine pulley diameter is 0.9 m.	BTL-6	Creating	PO1,PO2,PO3, PO7, PO8, PO12
6	For a flat belt drive, power transmitted 9 KW, 1500rpm electric motor to a compressor running at 500rpm. The distance between the centers of the pulley is twice the diameter of the larger pulley. The belt should operate at 16m/s and its thickness is 5mm. Density of leather is 9.8kg/m3 and permissible stress is 24MPa.	BTL-6	Creating	PO1,PO2,PO3, PO7, PO8, PO12

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

PART – A

CO Mapping : CO310.2

Q.No	Questions	BT Level	Competence	PO
1	What are the advantages of toothed gears over the other types of transmitted systems?	BTL-1	Remembering	PO1
2	Define transmission ratio with reference to spur gears?	BTL-1	Remembering	PO1
3	What is meant by spur-gear?	BTL-1	Remembering	PO1
4	Define module	BTL-4	Analyzing	PO1
5	State the conditions of correct gearing(or) state the law of gearing.	BTL-2	Understanding	PO1,PO2,PO4
6	What are the common forms of gear tooth profile?	BTL-1	Remembering	PO1
7	Define pitch circle with reference to spur gears.	BTL-1	Remembering	PO1
8	Why is pinion made harder than gear?	BTL-1	Remembering	PO1
9	List out the various methods of manufacturing a gear.	BTL-4	Analyzing	PO1
10	What are the main types of gear tooth failure?	BTL-1	Remembering	PO1
11	Who do you prefer helical gears than spur gears?	BTL-1	Remembering	PO1,PO2
12	Where do we use helical gears?	BTL-4	Analyzing	PO1,PO2
13	What is the major disadvantage of single helical gear? How can you overcome that difficulty?	BTL-1	Remembering	PO1,PO2

14	Define Backlash.	BTL-1	Remembering	PO1
15	Define Gear ratio.	BTL-1	Remembering	PO1
16	What is interference in gears?	BTL-1	Remembering	PO1
17	In what ways helical gears are differed from spur gears?	BTL-1	Remembering	PO1
18	What is helix angle?	BTL-4	Analyzing	PO1
19	Define Form factor.	BTL-1	Remembering	PO1,PO2
20	What are the effects of little backlash and excessive backlash on gears?	BTL-1	Remembering	PO1,PO2,PO6
21	Define the following terms. Tip, Root, Pitch Circle	BTL-1	Remembering	PO1,PO2
22	Why are gear drives superior to belt drives or chain drives? the advantages of gear drives?	BTL-1	Remembering	PO1,PO2,PO4
23	Define Pressure Angle.	BTL-1	Remembering	PO1
24	How do gears fail?	BTL-1	Remembering	PO1,PO2,PO5
25	What stresses are induced in gear tooth?	BTL-1	Remembering	PO1
26	What is meant by a corrected gear?	BTL-1	Remembering	PO1,PO2,PO3
27	Why dedendum Value is more than addendum value?	BTL-1	Remembering	PO1,PO2,PO3
28	What is a herringbone gears?	BTL-1	Remembering	PO1,PO2,PO3
29	Write any two applications of a skew gear-drive. (or) Where do we, use skew gears?	BTL-1	Remembering	PO1
30	What are the advantages of helical gears?	BTL-4	Analyzing	PO1
	PART – B & C			
1	In a spur gear, the gears are made of case iron and pinion is cast steel. The pinion is transmitting 30 KW at 400 rpm, to another shaft running at approximately 1000rpm. Design the drive's major dimensions, check for compressive and bending stresses. Take module as 10mm. Also check the design for dynamic load and wear	BTL-6	Creating	PO1,PO2, PO3,PO4,PO6, PO7, PO8, PO12
2	Design a straight spur gear drive. Transmitted power 8 KW pinion speed 764 rpm. Speed ratio is 2. The gears are to be made of C45 steel. Life is to be 10000hours.	BTL-6	Creating	PO1,PO2,PO4, PO5, PO7, PO8, PO12
3	Design a pair of spur gears to transmit 10 KW at 1440 rpm. Speed reduction is 3. Take pressure angle is 200 and working life of the gears as 15000 hrs. Assume the materials for pinion and wheel as heat treated cast steel and high grade cast iron respectively.	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8, PO12
4	Design a pair of helical gear drive to transmit 10 KW at 1000rpm of the pinion. Reduction ration of 5 is required. Give details of the drive in a tabular form.	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8, PO12
5	Design a helical gear drive to transmit 25 KW at 1440 rpm. Desired gear ratio is 3. Take helix angle as 23°. Use C45 steel for the gears with allowable beam stress of 90 MPa and hardness 250 BHN.	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8, PO12
6	Design a helical gear drive to transmit 14.7 KW at 1200 rpm. Desired speed ratio is 6. Take helix angle as 250 select the suitable material and design the gear.	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8, PO12

UNIT III BEVEL, WORM AND CROSS HELICAL GEARS

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

PART – A				
CO Mapping : CO310.3				
Q.No	**Questions**	**BT Level**	**Competence**	**PO**
1	What is a bevel gear?	BTL-1	Remembering	PO1
2	Differentiate a straight bevel gear and a spiral bevel gear.	BTL-2	Understanding	PO1,PO5
3	What are the advantages of spiral bevel gears over straight bevel gears?	BTL-1	Remembering	PO1,PO2
4	What is zero bevel gear?	BTL-1	Remembering	PO1
5	What is crown gear?	BTL-1	Remembering	PO1
6	What is Miter gears?	BTL-1	Remembering	PO1
7	For bevel gears, define 'back cone distance.'	BTL-2	Understanding	PO1,PO2
8	What are the forces acting on a bevel gear?	BTL-4	Analyzing	PO1,PO2
9	Under what situation, worm gears are used?	BTL-4	Analyzing	PO1,PO2,P06
10	Where do we use worm gears?	BTL-1	Remembering	PO1,PO2
11	What is irreversibility in worm gears?	BTL-1	Remembering	PO1,PO2
12	Define normal pitch of a worm gear?	BTL-1	Remembering	PO1
13	What is the velocity ratio range of worm gear drive?	BTL-1	Remembering	PO1,PO4
14	What is the virtual no of teeth in bevel gear?	BTL-1	Remembering	PO1,PO2
15	Why phosphor bronze is widely used for worm gears?	BTL-1	Remembering	PO1,PO2,PO3
16	How bevel gears are manufactured?	BTL-1	Remembering	PO1,PO2,PO3
17	In worm gear drive, only the wheel is designed. Why?	BTL-1	Remembering	PO1,PO2,PO5
18	For transmitting large power, worm reductions gears are not generally preferred why?	BTL-1	Remembering	PO1,PO2,PO5
19	What are the various losses in the worm gear?	BTL-4	Analyzing	PO1,PO2,PO3
20	In worm gearing heat removal is an important design requirement. Why?	BTL-2	Understanding	PO1,PO2,PO6
21	What is the specific feature of mitre gear?	BTL-2	Understanding	PO1
22	What are the merits and demerits of worm gear drive?	BTL-2	Understanding	PO1,PO2
23	In which gear-drive, self-locking is available?	BTL-1	Remembering	PO1,PO2
24	When do we use worm-gears?	BTL-1	Remembering	PO1,PO2
25	Define Cone Distance or pitch cone radius	BTL-2	Understanding	PO1,PO2
26	Define Face Angle.	BTL-1	Remembering	PO1,PO2
27	List out the main types of failure in worm gear drive:	BTL-2	Understanding	PO1,PO2
28	How are bevel gears classified?	BTL-2	Understanding	PO1,PO2
29	What is the velocity ratio range of worm gear drive?	BTL-1	Remembering	PO1,PO2
30	Under What situation, bevel gears are used?	BTL-1	Remembering	PO1,PO2,PO3
PART – B & C				
1	Design a pair of straight bevel gears for two shafts whose axes are at right angles to transmit 25KW. The speed of pinion is 300 rpm and of the fear is 120 rpm.	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8, PO12
2	2Design a pair of bevel gear to transmit 10kw at a pinion speed of 1440 rpm required transmission ration is 3, life of gear 10000hours pinion and gear are made of C45 steel and minimum no of teeth is 20.	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8, PO12
3	Design a bevel gear drive to transmit 7kw at 1600rpm for the following data, gear ratio is 3, material C45 steel, life is 10000hours.	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8, PO12
4	Design a worm gear drive to transmit a power of 22.5 KW. The worm speed is 1440 rpm. Velocity ratio is 24:1. An efficiency of 85% desired. The temperature raise should be restricted to 400C. Determine the required cooling area.	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8, PO12
5	A hardened steel worm rotates at 1440 rpm and transmits 12 KW to a phosphor bronze gear. The speed of the worm wheel should be 60±3% rpm. Design the worm gear if an efficiency of at least 82% is desired.	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8, PO12
6	A 2 kW power is applied to a worm shaft at 720 rpm. The worm is of quadruple start with 50mm as pitch circle diameter. The worm is of quadruple start type with 50mm as pitch circle	BTL-5	Evaluating	PO1,PO2, PO3,PO4, PO7, PO8,

	diameter. The worm gear has 40 teeth with 5mm module. The pressure angle in the diametral plane is 20°. Determine (i) the lead angle of the worm, (ii) velocity ratio, and (ii) centre distance. Also, calculate efficiency of the worm gear drive, and power lost in friction.			**PO12**

UNIT IV GEAR BOXES

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

PART – A

CO Mapping : CO310.4

Q.No	Questions	BT Level	Competence	PO
1	What situations demand use of gear boxes?	BTL-1	Remembering	PO1,PO2
2	Write any two requirements of a speed gear box.	BTL-1	Remembering	PO1,PO2
3	Why G.P series is selected for arranging the speeds in gear box?	BTL-1	Remembering	PO1,PO2,PO3
4	List any two methods used for changing speeds in gear boxes.	BTL-4	Analyzing	PO1,PO2,PO3
5	What are preferred Numbers?	BTL-1	Remembering	PO1,PO2,PO3
6	What is step ratio?(or) Define progression ratio.	BTL-1	Remembering	PO1,PO2
7	Why kinematic arrangement is as applied to gear boxes?	BTL-1	Remembering	PO1,PO2,PO3
8	What does the ray-diagram of gear box indicates?	BTL-1	Remembering	PO1,PO2,PO3
9	State any three basic rules to be followed while designing a gear box.	BTL-4	Analyzing	PO1
10	What are the possible arrangements to archive 12 speeds from a gear box?	BTL-1	Remembering	PO1,PO2
11	List out the possible arrangements to achieve 16 speed gear box.	BTL-4	Analyzing	PO1,PO2,PO3
12	What is a speed reducer	BTL-1	Remembering	PO1,PO2,PO3
13	What is the function of spacers in a gear-box	BTL-1	Remembering	PO1,PO2,PO3
14	What are the methods of lubrication in speed reducers	BTL-1	Remembering	PO1,PO2,PO3
15	In which gear-drive, self-locking is available	BTL-1	Remembering	PO1,PO2,PO3
16	What is the function of spacers in a gear box	BTL-1	Remembering	PO1,PO2,PO3
17	What are the commonly used gear tooth profiles	BTL-1	Remembering	PO1,PO2,PO3
18	What is step ratio? Name the series in which speeds of multi-speed gear box are arranged	BTL-1	Remembering	PO1,PO2,PO3
19	Give some applications of constant mesh gear box	BTL-4	Analyzing	PO1,PO2,PO3
20	List six standard speeds starting from 18 r.p.m with a step ratio 1.4	BTL-4	Analyzing	PO1,PO2,PO3
21	What purpose does the housing of gear-box serve	BTL-1	Remembering	PO1,PO2,PO3
22	What is the function of spacers in a gear-box?(6r) What are spacers as applied to a gear-box	BTL-1	Remembering	PO1,PO2,PO3
23	What is a speed diagram? (or) What is the structural diagram-of -&.gear-box	BTL-1	Remembering	PO1,PO2
24	For what purpose we are using gear-box	BTL-1	Remembering	PO1,PO2
25	Name the types of speed reducers	BTL-4	Analyzing	PO1,PO2,PO3
26	Draw the ray diagram for 6 speed gear box	BTL-2	Understanding	PO1,PO2,PO5
27	Draw the ray diagram for 9 speed gear box	BTL-2	Understanding	PO1,PO2,PO5
28	Draw the ray diagram for 12 speed gear box	BTL-2	Understanding	PO1,PO2,PO5
29	Draw the ray diagram for 16 speed gear box	BTL-2	Understanding	PO1,PO2,PO5
30	Draw the ray diagram for 18 speed gear box	BTL-2	Understanding	PO1,PO2,PO5

PART – B & C

1	Design a 12 speed gear box for a lathe. The minimum and maximum speeds are 100 and 1200 rpm. Power is 5 kw from 1440 rpm induction motor	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8, PO12
2	Design a nine – speed gear box for a machine to provide speeds ranging from 100 to 1500 rpm. The input is from a motor of 5 kW at 1440 rpm. Assume any alloy steel for the gear	BTL-6	Creating	PO1,PO2, PO3,PO4, PO7, PO8,

				PO12
3	Sketch the arrangements of a six speed gear box. The minimum and maximum speeds required are around 460 and 1400 rpm. Drive speed is 1440rpm. Construct speed diagram of the gear box and obtain various reduction rate. Use standard output speeds and standard step ratio. Calculate no of teeth in each gear and verify whether the actual output speeds are within 2% of standard speeds	**BTL-2**	**Understanding**	**PO1,PO2, PO3,PO4,PO5, PO7, PO8, PO12**
4	Draw the ray diagram and kinematic layout of a gear box for an all geared headstock of a lathe. The maximum and minimum speeds are to be 600 and 23 rpm respectively. Number of steps is 12 and drive is from a 3000W electric motor running at 1440rpm	**BTL-2**	**Understanding**	**PO1,PO2, PO3,PO4, PO7, PO8, PO12**
5	Design a 9speed gear box to give output speeds between 280 and 1800rpm. The input power is 5.5kw at 1440rpm. Draw the kinematic layout diagram and the speed diagram. Determine the number of teeth on all gears	**BTL-6**	**Creating**	**PO1,PO2, PO3,PO4, PO7, PO8, PO12**
6	In a milling machine, 18 different speeds in the range of 16 rpm and 1400 rpm are required. Design a three stage gear box with a standard step ratio. Sketch the layout of the gear box, indicating the number of teeth on each gear. The gear box receives 12 kW from an electric motor running at 1440 rpm. Sketch the layout of the gear box and draw the speed diagram	**BTL-6**	**Creating**	**PO1,PO2, PO3,PO4,PO5, PO7, PO8, PO12**

UNIT V CAMS, CLUTCHES AND BRAKES

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches- Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

PART – A

CO Mapping : CO310.5

Q.No	Questions	BT Level	Competence	PO
1	What is the function of a clutch	**BTL-1**	**Remembering**	**PO1**
2	Give examples for axial and radial friction clutches	**BTL-1**	**Understanding**	**PO1,PO2**
3	What are the properties required of the material used as a friction surface	**BTL-1**	**Remembering**	**PO1,PO2**
4	Name few commonly used friction materials	**BTL-1**	**Remembering**	**PO1,PO2**
5	Clutches are usually designed on the basic of uniform wear. Why	**BTL-1**	**Remembering**	**PO1,PO2**
6	Why a service factor is used for calculating the design capacity of a clutch	**BTL-1**	**Remembering**	**PO1,PO3**
7	What is the axial force required at the engagement and disengagement of cone clutch	**BTL-1**	**Remembering**	**PO1,PO2**
8	What is the difference between cone and centrifugal clutches	**BTL-1**	**Remembering**	**PO1,PO2**
9	Compare disc clutches and cone clutches	**BTL-4**	**Analyzing**	**PO1,PO2**
10	Why heat dissipation is necessary in clutches	**BTL-1**	**Remembering**	**PO1,PO2**
11	Give the relation to find temperature rise in clutches	**BTL-5**	**Evaluating**	**PO1,PO2**
12	What is the function of a brake	**BTL-1**	**Remembering**	**PO1**
13	Differentiate a brake and a clutch	**BTL-4**	**Analyzing**	**PO1**
14	Differentiate a brake and a dynamometer	**BTL-4**	**Analyzing**	**PO1**
15	Give examples for radial and axial brakes	**BTL-1**	**Remembering**	**PO1**
16	What are the types of brake linings	**BTL-1**	**Remembering**	**PO1**
17	What is a self-locking brake	**BTL-1**	**Remembering**	**PO1**
18	What you meant by self-energizing brake	**BTL-1**	**Remembering**	**PO1,PO2**
19	Which brake is commonly used in automobiles	**BTL-1**	**Remembering**	**PO1,PO2**
20	In what ways, the clutches are different from brakes	**BTL-1**	**Remembering**	**PO1**
21	What is cam	**BTL-1**	**Remembering**	**PO1,PO2**
22	Classification of cam	**BTL-2**	**Understanding**	**PO1,PO2**
23	Define Angle of ascend	**BTL-1**	**Remembering**	**PO1,PO2**
24	Define Angle of descend	**BTL-1**	**Remembering**	**PO1,PO2**

25	Define Angle of dwell	**BTL-1**	**Remembering**	**PO1,PO2**
26	Define Angle of action	**BTL-1**	**Remembering**	**PO1**
27	What is translating angle	**BTL-1**	**Remembering**	**PO1**
28	What is meant by positive clutch	**BTL-1**	**Remembering**	**PO1**
29	Why are cone clutches better than disc clutches	**BTL-1**	**Remembering**	**PO1,PO2**
30	What factors should be considered when designing friction clutches	**BTL-1**	**Remembering**	**PO1,PO2**
	PART – B & C			
1	A power of 20 KW is to be transmitted through a cone clutch at 500rpm. For uniform wear condition, find the main dimensions of the clutch and shaft. Also determine the axial force required to engage the clutch. Assume the coefficient of friction as 0.25, the maximum normal pressure on the friction surface is not to exceed 0.08 MPa and take the design stress for the shaft material as 40MPa	**BTL-5**	**Evaluating**	**PO1,PO2, PO3,PO4,PO5, PO7, PO8, PO12**
2	Design a differential band brake for a winch lifting a load of 20KN through a steel rope wound round a barrel of 600mm diameter. The brake drum, keyed to the barrel shaft, is of 800mm diameter and the angle of lap of the band over the drum is about 240o. Operating arm of the brake are 50mm and 250mm. Length of operating lever is 1.6m. Also calculate the effort applied	**BTL-6**	**Creating**	**PO1,PO2, PO3,PO4,PO5, PO7, PO8, PO12**
3	A plate clutch with maximum diameter 60mm has maximum lining pressure of 0.35 MPa. The power to be transmitted at 400 rpm is 135 KW and μ= 0.3. Find inside diameter and spring force required to engage the clutch. Springs with spring index 6 and material spring steel with safe shear stress 600 MPa are used. Find the diameters if 6 springs are used.	**BTL-1**	**Remembering**	**PO1,PO2, PO3,PO4,PO5, PO7, PO8, PO12**
4	A hydraulically operated clutch is to be designed for an automatic lathe. Determine the no of plates and operating force required for the clutch to transmit 35Nm. The clutch is to be designed to slip under 300% of rated torsional moment to protect the gears and other part of the drive. The limits for the diameter of friction surfaces due to space limitation are 100 mm and 62.5 mm. This clutch is to operate in an only atmosphere	**BTL-5**	**Evaluating**	**PO1,PO2, PO3,PO4,PO5, PO7, PO8, PO12**
5	An automobile single plate clutch consists of two parts of contacting surfaces. The inner and outer radii of friction plates are 120 and 250 mm. the coefficient of friction is 0.25 and the total axial force is 15KN. Calculate the power transmitting capacity of the clutch plate at 500 rpm using i) uniform wear theory ii) uniform pressure theory.	**BTL-1**	**Remembering**	**PO1,PO2, PO3,PO4,PO5, PO7, PO8, PO12**
6	A multi disc wet clutch is to be designed for a machine tool driven by an electric motor of 15 KW running at 1500 rpm. The clutch is fitted with steel and phosphor bronze plates arranged alternatively and run in oil. The Maximum torque to the transmitted is 30% greater than the mean torque. Sketch the arrangement of plates.	**BTL-2**	**Understanding**	**PO1,PO2, PO3,PO4,PO5, PO7, PO8, PO12**

UNIT I DESIGN OF FLEXIBLE ELEMENTS

Design of Flat belts and pulleys - Selection of V belts and pulleys – Selection of hoisting wire ropes and pulleys – Design of Transmission chains and Sprockets.

PART – A

1. Why are idler pulleys used in a belt drive?
   1. Idler pulley are provided to obtain high velocity ratio.
   2. Many idler pulleys are used when it is desired to transmit motion from one shaft to several parallel shafts.

2. When do you use stepped pulley drive?
A stepped or cone pulley drive is used for changing the speed of the driven shaft while the driving shaft runs at constant speed.

3. Explain the term crowning of pulleys. May 2014
Pulleys are provided. a -slight conical shapes (or)convex shapes in their rim's r surface in order to prevent the belt from running off the pulley due centrifugal force. This is known as crowning, of pulley. Usually the crowning height t may be 1/96 of pulley face width

4. State the law of belting.
Law of belting states that the centre line of the belt as it approaches the pulley must lie in a plane perpendicular to the axis of that pulley or must lie in the plane of the pulley, otherwise the belt will run off the pulley.

5. What is meant by ply in a flat belt?
Belts are specified according to the number of layers,e.g., single ply, double ply or triple ply.

6. What is centrifugal effect on belts?

(i) In operation as the belt passes over the pulley the centrifugal effect due to its self weight tends to lift the belt from the pulley surface. The reduces the normal reaction and hence the frictional resistance. (ii) The centrifugal force produces an additional tension in the belt.

7. What are the losses in belt drives? Nov 2014
The losses in a belt drive are due to:
(i) Slip and creep of the belt on the pulleys,
(ii) Windage or sir resistance to the movement of belt and pulleys.
(iii) Bending of the belt over the the pulleys and
(iv) Friction in the bearings of pulley.

8. Why a longer belt will last more than a shorter belt?
The life of a belt is a function of the centre distance between the driver and driven shafts. The shoter the belt, the more often it will be subjected to additional bending stresses while running around the pulleys at a given speed, and quicker it will be destroyed due to fatigue. Hence, a longer belt will last more than a shorter belt.

9. What is wipping? How it can be avoided in belt drives?

If the centre distance between two pulleys is too long then the belt begins to vibrate in a direction perpendicular to the direction of motion of belt. This phenomenon is called as wipping. Wipping can be avoided by using idlers pulleys.

10. State reasons for V-belt drive being preferred to flat belt drive? Nov 2017 May 2013
V-belt drive is preferred to the flat belt drive due to the following advantages:
*Power transmitted is more due to wedging action in the grooved pulley.
*Higher velocity ratio (up to 10) can be obtained.
*V-belt drive is more compact, quiet and shock absorbing.
*The drive positive because the slip is negligible.

11. How will you determine the number of belts required in the design of V-belt drives?
Number of V-belts=Total power transmitted / Power transmitted per belt

12. When do you prefer a chain drive to a belt or rope drive?
Chain drives are preferred for velocity ratio less than 10, chain velocities upto 25m/s, and for power ratings upto 125kW.

13. What are the different types of chains?
   1. Link(or welded load) chains,
   2. Transmission (or roller) chains,
   3. Silent (or inverted tooth) chains.

14. What are the applications of link (or hoisting) chains?
Link (or hoisting) chains are widely used
In low capacity machines such as hoists, winches and hand operated cranes as the main lifting appliances, and as slings for suspending the loas from hook or other device.

15. What is chordal action in chain drives? April 2015, 2010
Chordal action results in a pulsating and jerk motion of a chain.
In order to reduce the variation in chain speed, the number of teeth on the sprocket should be increased.

16. Why in chain drives, the sprocket has odd number of teeth and the chain has even number of links?
To facilitate more uniform wear, ie., the wear will be evenly distributed ans thus total wear will be lower.

17. What is a silent chain? In what situations, silent chains are preferred? Nov 2012
Inverted tooth chains are called silent chains because of their relatively quiet operation.
Silent Drives are preferred for high-power, high-speed, and smooth operation.

18. What are the possible ways by which a chain drive may fail? Nov 2017

The four basic modes of chain failure are: (i) Near: (ii) Fatigue; (iii) Impact and (iv) Galling.

19. Explain creep in belts.

Since the tensions produced by the belt on the two sides of the pulley are not equal, the belt moves with a very negligible velocity, due to the difference of two tensions. This slow movement of the belt over the pulley is known as creep of belt and it is generally neglected."

20. In what ways, timing belts are superior to ordinary V-belts? April-2015

Since the timing belts possess toothed shape in their -inner side, engagement with toothed pulley will provide positive drive without, belt-slip where as in the case of ordinary V-belts, chances of slip are and hence positive drive is not possible at all times. Hence toothed belts (I timing belts) are superior to ordinary V-belts

21. What is belt rating?

Flat-belts are made of different sizes such as 3 ply, 4 ply and V - belts are made of different grades such as A, B, C, D and E grade belts. Belt rating is defined as the power transmitting capacity of unit size flat belt or a particular grade single V belt.

22. State the materials for belts. May 2013, 2016

Leather, cotton fabrics, rubber, animal's hair, silk, rayon, woolen etc

23. How is wire-ropes designated? Nov 2012, 2009

A wire-rope is designated by the number of strands and the number of wires in each strand. For example, a wire rope having six strands, and each strand containing nineteen wires can be denoted as 6 x 19rope.

24. What are the various stresses induced in wire ropes?

a) Direct tensile load due to load and self-weight of the rope.
b) Bending stress when the rope winds round the drum.
c) Stresses due to changes in starting and stopping etc.

25. Mention the applications of chain drives. April 2011

Chain drives are employed in transportation machineries like motor-cycle, bi-cycles, automobiles and technological machineries, like agricultural machines, crushes etc.

26. What are the advantages of chain drives?

Chain drives

a) Are having more power transmitting capacity.
b) Have higher efficiency and compact size.
c) Exert -less load on shafts since no initial tension is applied on the sprocket shafts.
d) Require easy maintenance

27. Specify some drawbacks of chain drives. May 2017

a) The design of chain drive is more complicated.
b) The operation is noisy and production cost is high.
c) They require more accurate assembly of shafts than for belts.

28. What is a power drive? Mention their types.

The power drive is a set of machine members employed to transmit power or energy produced in one machine to another machine. Their main *types (1) Mechanical, (2) Hydraulic, (3) pneumatic and (4) Electrical drives.

29. What are the factors on which the coefficient of friction between the belt and pulley depends? May 2014, 2012

a) Direct tensile load due to load and self-weight of the rope.
b) Bending stress when the rope winds round the drum.
c) Stresses due to changes in starting and stopping etc.

30. In what ways wire ropes are superior to fiber ropes?

i. Wire ropes are stronger, more durable than fiber ropes.
ii. Wire ropes can withstand' shock loads.
iii. Their 'efficiency in high.
iv. They can be operated for Very long centre distance even up to 1000 m.

Hence wire-ropes are superior in most of occasions

PART – B & C

1. Design a V-belt drive and calculate average stress induced in the belt for the following specifications: Power to be transmitted 45 KW, Speed of driving wheel 1400 rpm, speed reduction factor is 3. Service 16 hours/ day. [Nov/Dec 2017] [May/June 2014]

   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 16.29

2. Design a V-belt drive and calculate the actual belt tension and average stress for the following data. Driven pulley diameter, D= 300 mm, driver pulley diameter, d=150 mm, speed N1 = 1400 rpm, N2 = 400 rpm and power, P = 75 kW. [May/June 2013]

   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 16.34

3. Design a chain drive to actuate a compressor from 15KW electric motor running at 1000rpm, the compressor speed being 350 rpm. The minimum centre distance is 500 mm. the compressor operates 15 hours/day. The chain

tension may be adjusted by shifting the motor. [May/June 2014, 2013]
Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no:15.13

4. A 7.5 KW electric motor running at 1400 rpm is used to drive the input shaft of the gear box of a machine. Design a suitable roller chain to connect the motor shaft to the gear box shaft to give an exact speed ratio of 10:1. The center distance is 600 mm. [May 2016, 2015]
Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 15.18

5. A belt is to transmit 25 KW at 720 rpm to a rolling machine with a speed ratio of 3. Centre distance between the pulleys is 2.8 m. design a suitable belt drive if the rolling machine pulley diameter is 0.9 m. [Nov/Dec 2012]
Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 16.23

6. For a flat belt drive, power transmitted 9 KW, 1500rpm electric motor to a compressor running at 500rpm. The distance between the centers of the pulley is twice the diameter of the larger pulley. The belt should operate at 16m/s and its thickness is 5mm. Density of leather is 9.8kg/m^3 and permissible stress is 24MPa. [May/June 2012]
Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 16.35

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS

Speed ratios and number of teeth-Force analysis -Tooth stresses - Dynamic effects – Fatigue strength - Factor of safety - Gear materials – Design of straight tooth spur & helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears.

PART – A

1. What are the advantages of toothed gears over the other types of transmitted systems?
Ans: Advantages of toothed gears are:
*Since there is no slip, so extact velocity ratio is obtained.
*It is capable of transmitting larger power.
* It is more efficiency and effective means of power transmission.

2. Define transmission ratio with reference to spur gears?
Ans: It is the ratio of speed of driving gear to the speed of the driven gear.

3. What is meant by spur-gear?
Spur-gear is the gear in which teeth are cut at the circumference of a slab called as gear- blank such that the teeth are parallel to gear-axis.

4. Define module. May 2013, 2011
It is the ratio of the pitch circle diameter to the number of teeth.

5. State the conditions of correct gearing(or) state the law of gearing. April 2015, Nov 2010
Ans: The law of gearing states that for obtaining a constant velocity ratio, at any instant of teeth the common normal at each of contact should always pass through a pitch point, situated on the line joining the centres of rotation of the pair of mating gears.

6. What are the common forms of gear tooth profile?
Ans: 1. Involute tooth profile, and 2. Cycloidal tooth profile.

7. Define pitch circle with reference to spur gears.
Ans: Pitch circle is an imaginary circle which by pure rolling action, would give the same motion as the actual gear.

8. Why is pinion made harder than gear? Nov 2012
Ans: Because the teeth of pinion undergo more number of cycles than those of gear and hence quicker wear.

9. List out the various methods of manufacturing a gear.
Ans: 1. Gear milling.
2. Gear generating i) Gear hobbing;(ii)Gear shaping.
3.Gear molding i) Injection molding;(ii)Die casting;(iii) Investment casting.

10. What are the main types of gear tooth failure? May 2013, 2012
Ans:1. Tooth breakage(due to static and dynamic loads)
2. Tooth wear(or surface deterioration) (a) Abrasion;(b)pitting; and(c) Scoring or seizure.

11. Who do you prefer helical gears than spur gears?
Ans: Helical gears produce less noise than spur gears.
Helical gears have a greater load capacity than equivalent spur gears.

12. Where do we use helical gears?
Ans: Helical gears are commonly used in automobiles, turbines, and high speed applications.

13. What is the major disadvantage of single helical gear? How can you overcome that difficulty?
Ans: Single helical gears are subjected to axial thrust loads. This axial thrust loads can be eliminated by using double helical (i.e., herringbone) gears.

14. Define Backlash.

Back lash is the difference between tooth thickness and the space into 'which it meshes, measured along the pitch circle. If we assume the tooth thickness as t, and space width as t2 then backlash = t2 – tl

15. Define Gear ratio.

Gear ratio is the ratio of number of teeth of larger gear to that of smaller gear. At is also defined as the ratio of high speed to the low speed in a gear drive.

16. What is interference in gears?

Gear profile usually starts, from base circle and ends with tip teeth are made in such a way that their contact is along the pro the top surface of teeth is made, flat, the tip of the teeth of one gear dig I into the bottom flank of mating gear. This action is called interference.

17. In what ways helical gears are differed from spur gears. May 2017 Nov 2012

Spur gears	Helical gears
Teeth are cut parallel to the axis.	Teeth are cut inclined to the axis.
Entire width of tooth is	Gradual engagement is obtained
simultaneously engaged with full	since their teeth are inclined to
width of mating gear.	axis.
Rough and noisy operation	Smooth and silent operation.
Less power is transmitted.	More power can be. transmitted.

18. What is helix angle?

Helix angle -is the angle between the axis of the gear and the through tooth face. For helical gear, teeth are cut at an inclined axis, specified as'helix angle and its value ranges from 80to25' the case of spur gear, tooth-are cut parallel to the axis, the spur gear is zero.

19. Define Form factor.

Form factor is a constant, employed in the design of gear which, design the shape and the number of teeth.

20. What are the effects of little backlash and excessive backlash on gears

Too little backlash may lead to over loading, overheating and ultimately seizure resulting eventual failure of the system. On the excessive backlash may cause, non uniform – transmission of motion. backlash may also cause noise and impact loads.

21. Define the following terms.

i) Tip circle or addendum circle is the circle which coincides crests or tops of all teeth.

ii)Root circle or addendum circle is the circle which coincides with. roots or bottoms of all teeth.

iii) Pitch circle is the imaginary circle in which the pair of gears rolls one over the other. This circle can be visible when the pair of gears fastly rotating. This will lie between tip circle and root circle.

22. Why are gear drives superior to belt drives or chain drives? the advantages of gear drives?

i) The gear drives possess high load carrying capacity, high compact layout.

ii) They can transmit power from very small values to several kilowatts.

23. Define Pressure Angle. April 2015, 2014, 2013

It is the angle making by the line of action common- tangent to the pitch circles of mating pairs

24. How do gears fail?

Gears may fail due to tooth breakage by a) overload and misalignment of shafts. b) corrosion of teeth by improper lubricants. c) tooth wear because of insufficient lubrication. d) interference because of no under-cut.

25. What stresses are induced in gear tooth?

a) Surface compressive stress.

b) Bending stress.

26. What is meant by a corrected gear?

In normal gear, there may be an undercut between base circle and root circle which weakens the teeth. This undercutting can be avoided by making some modifications on the gear profile. This modification is addendum modification or profile correction or profile shift. The gear, which has this correction, is called as corrected gear.

27. Why dedendum Value is more than addendum value?

In order to get clearance between the teeth of one gear and bottom surface of mating gear so as to avoid interference, dedendum is having more value than addendum.

28. What is a herringbone gears? May 2016, 2015

A herring bone gear is made of two single helical gears attached other hence called as double helical gear in which the teeth of be set in the opposite direction to the teeth of another gear arrangement the axial thrust produced in one gear will be null', thrust produced in another gear, and the resultant thrust improves the life of the gear.

29. Write any two applications of a skew gear-drive. (or) Where do we, use skew gears?

The skew gears or crossed helical gears are employed in instruments, distributor drive of automobile engine etc, where small loads are applied.

30. What are the advantages of helical gears?

Transmit more power, Provide smooth and soundless operation, Used for high speed and high velocity ratio processes.

PART – B & C

1. In a spur gear, the gears are made of case iron and pinion is cast steel. The pinion is transmitting 30 KW at 400 rpm, to another shaft running at approximately 1000rpm. Design the drive's major dimensions, check for compressive and bending stresses. Take module as 10mm. Also check the design for dynamic load and wear. [May/June 2014]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 18.52

2. Design a straight spur gear drive. Transmitted power 8 KW pinion speed 764 rpm. Speed ratio is 2. The gears are to be made of C45 steel. Life is to be 10000hours. [May/June 2013]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 18.28

3. Design a pair of spur gears to transmit 10 KW at 1440 rpm. Speed reduction is 3. Take pressure angle is 20^0 and working life of the gears as 15000 hrs. Assume the materials for pinion and wheel as heat treated cast steel and high grade cast iron respectively. [Nov/Dec 2017] [Nov/Dec 2012]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 18.59

4. Design a pair of helical gear drive to transmit 10 KW at 1000rpm of the pinion. Reduction ration of 5 is required. Give details of the drive in a tabular form. [Nov/Dec 2017] [May/June 2013]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 18.44

5. Design a helical gear drive to transmit 25 KW at 1440 rpm. Desired gear ratio is 3. Take helix angle as 23°. Use C45 steel for the gears with allowable beam stress of 90 MPa and hardness 250 BHN. [May/June 2014]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 18.61

6. Design a helical gear drive to transmit 14.7 KW at 1200 rpm. Desired speed ratio is 6. Take helix angle as 25^0 select the suitable material and design the gear. [May/June 2015]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 18.48

UNIT III BEVEL, WORM AND CROSS HELICAL GEARS

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of pair of straight bevel gears. Worm Gear: Merits and demerits terminology. Thermal capacity, materials-forces and stresses, efficiency, estimating the size of the worm gear pair. Cross helical: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

PART – A

1. What is a bevel gear?

Bevel gear is the type of gear for Which the teeth are cut on conical surface in contrast with spur and helical gears for which the teeth are cut on cylindrical surfaces. The structure of bevel gear is similar to and uniformly truncated frustum of a cone.

2. Differentiate a straight bevel gear and a spiral bevel gear.

Ans: When teeth formed on the cones are straight, the gears are known as straight bevel and when inclined, they are known as spiral or helical bevel.

3. What are the advantages of spiral bevel gears over straight bevel gears?

Ans: Spiral bevel gears are smoother in action and quieter than straight bevel gears.

4. What is zero bevel gear? April 2015

Ans: Spiral bevel gear with curved teeth but with a zero degree spiral angle is known as Zero bevel gear.

5. What is crown gear?

Ans: A bevel gear having a pinch angle of 90°and a plane for its pitch surface is known as a crown gear.

6. What is Miter gears? Nov 2017

Equal bevel gears when they connect two shafts at right angles are known as miter gears.

7. For bevel gears, define 'back cone distance.'

Ans: Back cone distance is the length of the back cone. Back cone is an imaginary cone, perpendicular to the pitch cone at the end of the tooth.

8. What are the forces acting on a bevel gear? May 2013

Ans; 1. Tangential force,
2. Axial force, and

3. Radial force.

9. Under what situation, worm gears are used?

Ans: The worm gears are used to transmit power between two non-intersecting, non-parallel shafts, and for high speed ratios as high as 300:1.

10. Where do we use worm gears? May 2013

Ans: Worm gears used as a speed reducer in materials handling equipment, machine tools and automobiles.

11. What is irreversibility in worm gears?

Ans: The worm gear drives are irreversible. It means that the motion cannot be transmitted from worm wheel to the worm. This property of irreversible is advantageous in load hosting applications like cranes and lifts.

12. Define normal pitch of a worm gear?

Ans: It is the distance measured along the normal to the threads between two corresponding points on two adjacent threads of the worm.

13. What is the velocity ratio range of worm gear drive?

Ans: Velocity ratio ranges from 10:1 to 300:1

14. What is the virtual no of teeth in bevel gear? May 2014, Nov 2014

An imaginary spur gear considered in a plane perpendicular to the tooth at a larger end is known as virtual or formative or equivalent spur gear

15. Why phosphor bronze is widely used for worm gears?

Ans: Phosphur bronze have high antifriction properties to resist seizure. Because in worm gear drive, the failure due to seizure is more.

16. How bevel gears are manufactured? May 2016

Bevel gears are not interchangeable and are designed in pairs. Since bevel gears are cut on conical surfaces, the height of tooth will not be uniform.

17. In worm gear drive, only the wheel is designed. Why? May 2011

Ans: Since always the strength of the worm is greater than the worm wheel, therefore only worm wheel is designed.

18. For transmitting large power, worm reductions gears are not generally preferred why?

Ans: In worm drive, meshing occurs with sliding action. Since sliding occurs, the amount of heat generation and power loss are quite high.

19. What are the various losses in the worm gear? May 2012

Ans: * Losses due to friction is sliding (i.e., gearing loss), and
*Losses due to the churning and splashing of lubricating oil.

20. In worm gearing heat removal is an important design requirement. Why?

Ans: Because the worm gear drives produce much heat. Unless proper heat removal is provided. The drive may eventually fail by seizure

21. What is the specific feature of mitre gear?

Mitre gear is the special type of crown gear in-twhich the shaft,, 900 and the pitch angles of pinion and gear are equal and each angle to 45'.

22. What are the merits and demerits of worm gear drive? Nov 2017

Merits

a. Used for very high velocity ratio of about 100
b. Smooth and noiseless operation.
c. Self-locking facility is available.

Demerits

a. Low efficiency.
b. More heat will be produced and hence this drive can be operated inside an oil reservoir or extra cooling fan is required in order to dissipate the heat from the drive.
c. Low power transmission.

23. In which gear-drive, self-locking is available? April 2015

Self locking is available in worm-gear drive.

24. When do we use worm-gears? Nov 2014

When we need to transmit power between nonparallel and non-intersecting shafts and very high velocity ratio, of about 100, worm gears, can be employed. Also worm-gears provide self-locking facility.

25. Define Cone Distance or pitch cone radius. May 2014

Cone distance or pitch cone radius is the slant length of pitch cone, i.e., distance between the apex and the extreme point of tooth of bevel gear.

26. Define Face Angle. May 2014

Face angle is the angle subtended by the face of the teeth at the cone centre. It is equal to the pitch angle plus addendum angle. It is also called as tip angle.

27. List out the main types of failure in worm gear drive:

Ans: 1. Seizure: 2. Pitting and rupture.

28. How are bevel gears classified? May 2012

Bevel gears are classified in two ways

Based on the shape of teeth.

i. Straight bevel gears
ii. Spiral bevel gears

e. Based on the included angle between the shaft axes, called as shaft angle

i. External gears < 90^0) ii. Internal gears > 90^0) iii. Crown gears 90^0

29. What is the velocity ratio range of worm gear drive?
Ans: Velocity ratio ranges from 10:1 to 300:1

30. Under What situation, bevel gears are used?
Ans: Bevel gears are used to transmit power between two intersecting shafts.

PART – B & C

1. Design a pair of straight bevel gears for two shafts whose axes are at right angles to transmit 25KW. The speed of pinion is 300 rpm and of the gear is 120 rpm. [May/June 2015]
Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 19.32

2. Design a pair of bevel gear to transmit 10kw at a pinion speed of 1440 rpm required transmission ration is 3, life of gear 10000hours pinion and gear are made of C45 steel and minimum no of teeth is 20. [Nov/Dec 2017] [May/June 2014
Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no:19.23

3. Design a bevel gear drive to transmit 7kw at 1600rpm for the following data, gear ratio is 3, material C45 steel, life is 10000hours. [May/June 2017] [May/June 2013]
Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no:19.23

4. Design a worm gear drive to transmit a power of 22.5 KW. The worm speed is 1440 rpm. Velocity ratio is 24:1. An efficiency of 85% desired. The temperature raise should be restricted to 40^0C. Determine the required cooling area. [Nov/Dec 2017] [May/June 2015, 2013]
Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no:19.44

5. A hardened steel worm rotates at 1440 rpm and transmits 12 KW to a phosphor bronze gear. The speed of the worm wheel should be 60±3% rpm. Design the worm gear if an efficiency of at least 82% is desired. [May/June 2017] [Nov/Dec 2014]
Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no:19.45

6. A 2 kW power is applied to a worm shaft at 720 rpm. The worm is of quadruple start with 50mm as pitch circle diameter. The worm is of quadruple start type with 50mm as pitch circle diameter. The worm gear has 40 teeth with 5mm module. The pressure angle in the diametral plane is 20°. Determine (i) the lead angle of the worm, (ii) velocity ratio, and (ii) centre distance. Also, calculate efficiency of the worm gear drive, and power lost in friction. [May/June 2014]
Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 19.46

UNIT IV GEAR BOXES

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Design of multi speed gear box for machine tool applications - Constant mesh gear box - Speed reducer unit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications.

PART – A

1. What situations demand use of gear boxes?
Ans: Gear boxes are required wherever the variable spindle speeds is necessary

2. Write any two requirements of a speed gear box.
Ans: *Gear box should provide the designed series of spindle speeds.
*Gear box should transmit the required amount of power to the spindle.

3. Why G.P series is selected for arranging the speeds in gear box? May 2017
Ans: The speed of loss is minimum , if G.P is used.
The Number of gears to be even range of spindle speeds at each step.
G.P provide a more even range of spindle speed at each step.
The layout is comparatively very compact, if G.P is used.

4. List any two methods used for changing speeds in gear boxes.
Ans: Sliding mesh gear box, and
Constant mesh gear box.

5. What are preferred Numbers? Nov 2014, May 2013, 2011
Ans: Prefered numbers are the conventionally rounded off values derived from geometric series. There are five basic series denoted as R 5, R 10, R 20, R 40 and R 80 series.

6. What is step ratio?(or) Define progression ratio.
Ans: When the spindle speeds are arranged in geometric progression, then the ratio between the two adjacent speeds is

known as step ratio or progression ratio.

7. Why kinematic arrangement is as applied to gear boxes? May 2014

Ans: The kinematic layout shows the arrangement of gears in a gear box. It also provides information's like number of speeds available at each spindle and the number of stages used.

8. What does the ray-diagram of gear box indicates? May 2012

Ans: The ray diagram is a graphical representation of the drive arrangement in general form. It serves to determine the specific values of all the transmission ratios and speed of all the shafts in the drive.

9. State any three basic rules to be followed while designing a gear box. Nov 2017

Ans:1. The transmission ratio(i) in a gear box is limited by ¼< i< 2.

2. For stable operation, the speed ratio of any stage should not be greater than 8. i.e.,Nmax/Nmin < 8.

10. What are the possible arrangements to archive 12 speeds from a gear box? May 2013, 2011

Ans: The possible arrangements are:

3x2x2 scheme; (ii) 2x3x2 scheme ; and (iii) 2x2x3 scheme.

11. List out the possible arrangements to achieve 16 speed gear box.

Ans: (i) 4x2x2 scheme; (2x4x2 scheme; and (iii) 2x2x4 scheme.

12. What is a speed reducer?

Ans: Speed reducer is a gear mechanism with a constant speed ratio, to reduce the angular speed of output shaft as compared with that of input shaft.

13. What is the function of spacers in a gear-box?

Ans: The function of spacers is to provide the necessary distance between the gears and the bearings.

14. What are the methods of lubrication in speed reducers?

Ans: 1. Splash or spray lubricating method, and

2. Pressure lubrication method.

15. In which gear-drive, self-locking is available? April 2015

Ans: In the worm gear drive, self-locking is available.

16. What is the function of spacers in a gear box?

Ans: The function of spacers is to provide the necessary distance between the gears and the bearings.

17. What are the commonly used gear tooth profiles? Nov 2012

Ans: 1. Involute tooth profile, and 2. Cycloidal tooth profile

18. What is step ratio? Name the series in which speeds of multi-speed gear box are arranged.

May 2013

Ans: When the spindle speeds are arranged in geometric progression, then the ratio between the two adjacent speeds is known as step ratio.

19. Give some applications of constant mesh gear box. Nov 2012

Ans: Constant mesh gear boxes are employed in various machine tools viz., lathe, milling machines, etc., to provide a wide range of spindle speeds.

20. List six standard speeds starting from 18 r.p.m with a step ratio 1.4.

Ans: For the step ratio Φ=`.4, the R20 series is used. From R20 series, the standard speeds are 18,20,22.4,25,238 and 31.5 rpm.

21. What purpose does the housing of gear-box serve?

Gear-box -housing or casing is used as container inside which, the gears, shafts, bearings and other components are "mounted.' Also it prevents the entry of dust inside the housing and reduces noise of operation. That is, the housing Safe-guard the inner components.

22. What is the function of spacers in a gear-box?(6r) What are spacers as applied to a gear-box?

Spacers are sleeve like components, which are mounted, in shafts in-between gears and bearings or one gear and another gear in order to maintain the distance between them so as to avoid interruption between them.

23. What is a speed diagram? (or) What is the structural diagram-of -&.gear-box? May 2017

Speed diagram or structural diagram is the graphical representation different speeds of output shaft, motor shaft and intermediate shafts.

24. For what purpose we are using gear-box?

Since the gear-box is provided with number of gears of different size arranged is different forms, we can get number of output speeds by operated motor at single speed.

25. Name the types of speed reducers.

a. Single reduction speed reduces.

b. Multi reduction speed reducers.

26. Draw the ray diagram for 6 speed gear box. April 2015

27. Draw the ray diagram for 9 speed gear box.

28. Draw the ray diagram for 12 speed gear box. Nov 2017

29. Draw the ray diagram for 16 speed gear box.

30. Draw the ray diagram for 18 speed gear box.

PART – B & C

1. Design a 12 speed gear box for a lathe. The minimum and maximum speeds are 100 and 1200 rpm. Power is 5 kw from 1440 rpm induction motor. [Nov/Dec 2012] [May/June 2015] [May/June 2015]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no:20.27

2. Design a nine – speed gear box for a machine to provide speeds ranging from 100 to 1500 rpm. The input is from a motor of 5 kW at 1440 rpm. Assume any alloy steel for the gear. [May/June 2014]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 20.20

3. Sketch the arrangements of a six speed gear box. The minimum and maximum speeds required are around 460 and 1400 rpm. Drive speed is 1440rpm. Construct speed diagram of the gear box and obtain various reduction rate. Use standard output speeds and standard step ratio. Calculate no of teeth in each gear and verify whether the actual output speeds are within 2% of standard speeds. [May/June 2014]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no:20.10

4. Draw the ray diagram and kinematic layout of a gear box for an all geared headstock of a lathe. The maximum and minimum speeds are to be 600 and 23 rpm respectively. Number of steps is 12 and drive is from a 3000W electric motor running at 1440rpm. [May/June 2014]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no: 20.16

5. Design a 9speed gear box to give output speeds between 280 and 1800rpm. The input power is 5.5kw at 1440rpm. Draw the kinematic layout diagram and the speed diagram. Determine the number of teeth on all gears. [May/June 2013]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no:20.26

6. In a milling machine, 18 different speeds in the range of 16 rpm and 1400 rpm are required. Design a three stage gear box with a standard step ratio. Sketch the layout of the gear box, indicating the number of teeth on each gear. The gear box receives 12 kW from an electric motor running at 1440 rpm. Sketch the layout of the gear box and draw the speed diagram. [May/June 2012]
   Refer: "Machine Design by T.V Sundararajamoorthy, V.Shanmugam" Page no:20.26

UNIT V CAMS, CLUTCHES AND BRAKES

Cam Design: Types-pressure angle and under cutting base circle determination-forces and surface stresses. Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches- Electromagnetic clutches. Band and Block brakes - external shoe brakes – Internal expanding shoe brake.

PART – A

1. What is the function of a clutch? May 2016

Ans: The clutch is mechanical device which is used to connect or disconnect the source of power at the operator's will.

2. Give examples for axial and radial friction clutches.

Ans: 1. Axial friction clutches: Disc and cone clutches.
2.Radial friction clutches: Centrifugal, internal expanding rim and external contracting rim clutches.

3. What are the properties required of the material used as a friction surface? May 2010

Ans: The properties required of the friction materials are:
*A high and uniform coefficient of friction.
*Geed resiliency.
*The ability to withstand high temperatures, together with good heat conductivity.

4. Name few commonly used friction materials. May 2011

Ans: Wood, clerk, leather, asbestos based friction materials, and powdered metal friction materials.

5. Clutches are usually designed on the basic of uniform wear. Why?

Ans: In clutches, the value of normal pressure, axial load for the given clutch is limited by the rate of wear that can be tolerated in the brake linings. Moreover, the assumption of uniform wear rate gives a lower calculated clutch capacity than the assumption of uniform pressure. Hence clutches are usually designed on the basis of uniform wear.

6. Why a service factor is used for calculating the design capacity of a clutch?

Ans: In order to start a load from rest and accelerate it, a clutch should have torque capacity substantially greater than the nominal; torque requirement so that the load can be accelerated without excessive slip.

7. What is the axial force required at the engagement and disengagement of cone clutch?

$W = W\,n(1+\mu \operatorname{Cot} \alpha)$

8. What is the difference between cone and centrifugal clutches?

Ans: Cone clutch works on the principle of friction alone. But centrifugal clutch uses principle of centrifugal force in addition with it.

9. Compare disc clutches and cone clutches.

Ans:* In disc clutches, friction lined flat plates are used.

*In cone clutches, friction lined frustum of cone is used.

10. Why heat dissipation is necessary in clutches?

Ans: When clutch engages, most of the work done (against friction forces opposing the motion) will be liberated as heat at the interface. Consequently the temperature of the rubbing surface will increase. This increased temperature may destroy the clutch. So heat dissipation is necessary in clutches.

11. Give the relation to find temperature rise in clutches.

Temperature rise, $\Delta T = \frac{E}{C \times m}$

Where E= Energy dissipated by the clutch.

C=Specific heat of clutch material, and

M=Mass of the clutch.

12. What is the function of a brake?

Ans: Brake is a mechanical device by means of which motion of a body is retarded for slowing down or to bring it to rest, by applying artificial frictional resistance.

13. Differentiate a brake and a clutch.

Ans: A clutch connects two moving members of a machine, whereas a brake connects a moving member to a stationary member.

14. Differentiate a brake and a dynamometer. May 2017

Ans: A dynamometer is a brake incorporating a device to measure the frictional resistance applied.

15. Give examples for radial and axial brakes.

Ans: Radial brakes: Band brakes, block brakes, and internal expanding rim.

Axial brakes : Cone brakes and disc brakes.

16. What are the types of brake linings?

Ans: 1. Organic linings. 2. Semi-metallic linings and 3. Metallic linings.

17. What is a self-locking brake? May 2013, Nov 2012, May 2011

Ans: When the frictional force is sufficient enough to apply the brake with no external force, then the brake is said to be self-locking brake.

18. What you meant by self-energizing brake? Nov 2017, May 2014, 2010

Ans: When the moment of applied force (F.l) and the moment of the frictional force (μ. R N.C) are in the same direction, then frictional force helps in applying the brake. This type of brake is known as a self- energizing brake.

19. Which brake is commonly used in automobiles?

The brake commonly used in automobiles is Internal expanding brake.

20. In what ways, the clutches are different from brakes?

The clutch used to engage the driving and driven members and keep them moving (i.e., rotating) together, where as brakes are employed to stop a moving member or reduce its speed.

21. What is cam?

Cam is a rotating mechanical member used for transmitting desired motion to a follower by direct contact

22. Classification of cam?

a) according to cam shape
b) according to follower movement
c) according to manner of constraint of the follower

23. Define Angle of ascend?

The angle of rotation of the cam from the position when the follower begins to rise till it reaches its highest points, it is denoted by θ

24. Define Angle of descend?

The angle through which the cam rotates during the time the follower returns to the initial position. It is denoted by θr.

25. Define Angle of dwell?

It is the angle through which the cam rotates while the follower remains stationary at the highest or the lowest.

26. Define Angle of action?

The total angle moved by the cam during its rotation between the beginning of rise and the end of return of the follower

27. What is translating angle?

The wedge is replaced by a flat plate with a groove. The plate cam moves back and forth, imparting a translatory motion to

the follower. Thus these cams are also known as translating cams.

28. What s meant by positive clutch?

Which transmits power from driving shaft to the driven shaft by jaws or teeth is called positive clutch. No slipping is there.

29. Why are cone clutches better than disc clutches?

Since the cone discs are having large frictional areas and they can transmit a larger torque than disc clutches with, the same oil diameter and actuating force and hence cone clutches are preferred over disk clutches. But usually cone clutches are mainly used in low peripheral applications.

30. What factors should be considered when designing friction clutches?

a) The friction materials for the clutch should have high co-efficient of friction and-they should not be affected by moisture and oil.

b) May be light in weight.

c) The design is in such a way that the engagement should be made without shock and fast disengagement without drag.

PART – B & C

1. A power of 20 KW is to be transmitted through a cone clutch at 500rpm. For uniform wear condition, find the main dimensions of the clutch and shaft. Also determine the axial force required to engage the clutch. Assume the coefficient of friction as 0.25, the maximum normal pressure on the friction surface is not to exceed 0.08 MPa and take the design stress for the shaft material as 40MPa. [May/June 2015]
Refer: "Design of Machine Elements - Bhandari V" Page no: 338

2. Design a differential band brake for a winch lifting a load of 20KN through a steel rope wound round a barrel of 600mm diameter. The brake drum, keyed to the barrel shaft, is of 800mm diameter and the angle of lap of the band over the drum is about 240o. Operating arm of the brake are 50mm and 250mm. Length of operating lever is 1.6m. Also calculate the effort applied. [May/June 2015]
Refer: "Design of Machine Elements - Bhandari V" Page no:368

3. A plate clutch with maximum diameter 60mm has maximum lining pressure of 0.35 MPa. The power to be transmitted at 400 rpm is 135 KW and μ= 0.3. Find inside diameter and spring force required to engage the clutch. Springs with spring index 6 and material spring steel with safe shear stress 600 MPa are used. Find the diameters if 6 springs are used. [May/June 2014]
Refer: "Design of Machine Elements - Bhandari V" Page no: 344

4. A hydraulically operated clutch is to be designed for an automatic lathe. Determine the no of plates and operating force required for the clutch to transmit 35Nm. The clutch is to be designed to slip under 300% of rated torsional moment to protect the gears and other part of the drive. The limits for the diameter of friction surfaces due to space limitation are 100 mm and 62.5 mm. This clutch is to operate in an only atmosphere. [May/June 2014]
Refer: "Design of Machine Elements - Bhandari V" Page no: 344

5. An automobile single plate clutch consists of two parts of contacting surfaces. The inner and outer radii of friction plates are 120 and 250 mm. the coefficient of friction is 0.25 and the total axial force is 15KN. Calculate the power transmitting capacity of the clutch plate at 500 rpm using i) uniform wear theory ii) uniform pressure theory. [May/June 2013]
Refer: "Design of Machine Elements - Bhandari V" Page no:329

6. A multi disc wet clutch is to be designed for a machine tool driven by an electric motor of 15 KW running at 1500 rpm. The clutch is fitted with steel and phosphor bronze plates arranged alternatively and run in oil. The Maximum torque to the transmitted is 30% greater than the mean torque. Sketch the arrangement of plates. [May/June 2012]
Refer: "Design of Machine Elements - Bhandari V" Page no: 333