# SRM VALLIAMMAI ENGINEERING COLLEGE

**(An Autonomous Institution)**

**SRM Nagar, Kattankulathur – 603 203**

## DEPARTMENT OF MECHANICAL ENGINEERING

**QUESTION BANK**

**VI SEMESTER**

**1909601- DESIGN OF TRANSMISSION SYSTEMS**

**Regulation – R 2019**

**Academic Year 2024-25**

**Prepared by:**

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**SRM NAGAR, KATTANKULATHUR-603203**

**DEPARTMENT OF MECHANICAL ENGINEERING**

**QUESTION BANK**

| UNIT I - DESIGN OF FLEXIBLE ELEMENTS | | | |
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| 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 (2 Marks)** | | | |
| **Q.No** | **QUESTIONS** | **BT Level** | **Competence** |
| 1 | Distinguish between open drive and cross drive of a belt drive. | BT-1 | Remembering |
| 2 | In what ways the timing belts are superior to ordinary V-belts? | BT-2 | Understanding |
| 3 | Define the term " Crowning of pulley" | BT-1 | Remembering |
| 4 | List the desirable properties of a belt material. | BT-1 | Remembering |
| 5 | Classify belt drives used for power transmissions. | BT-2 | Understanding |
| 6 | What are the factors to be considered while design the belt drive? | BT-1 | Remembering |
| 7 | Write notes on Slack adjuster. | BT-2 | Understanding |
| 8 | Mention the losses in belt drives. | BT-2 | Understanding |
| 9 | Summarize the centrifugal effects on belts. | BT-1 | Remembering |
| 10 | List the belt materials used to fabricate the belts on transmission systems. | BT-2 | Understanding |
| 11 | Define maximum tension in a belt. | BT-2 | Understanding |
| 12 | Why slip is less in case of V-belts when compared to flat belts? | BT-4 | Analysing |
| 13 | Sketch the cross section of V-belt and label its important parts. | BT-1 | Remembering |
| 14 | How the wire ropes are designed? Write any four rope applications. | BT-2 | Understanding |
| 15 | Sketch and name the different types of compound wire ropes. | BT-1 | Remembering |
| 16 | Under what circumstances chain drives are preferred over V belt drives? | BT-4 | Analysing |
| 17 | List the factors that affect the working conditions of chain drive. | BT-2 | Understanding |
| 18 | Name four elements in a chain? Give any three applications of chain drive. | BT-1 | Remembering |
| 19 | Write notes on chordal action in chain drives. | BT-2 | Understanding |
| 20 | Define coefficient of friction. What do you meant by angle of friction? | BT-1 | Remembering |
| 21 | What is a power drive? Mention their types. | BT-1 | Remembering |
| 22 | State the -Law of Belting' | BT-2 | Understanding |

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| 23 | Briefiy explain about friction and its applications. | BT-1 | Remembering |
| 24 | Indicate some merits and demerits of belt-drive; | BT-1 | Remembering |
| 25 | Explain creep in belts. | BT-2 | Understanding |

| **PART-B (13 Marks)** | | | |
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| **Q.No** | **QUESTIONS** | **BT Level** | **Competence** |
| 1 | Calculate the power capacity of the leather belt of 9mm x 250mm is used to drive a CI pulley 900mm in diameter at 336rpm. If the active arc on the smaller pulley is $120^{o}$ and stress in tight side is 2Mpa. The density of the leather may be taken as 980 kg/$m^3$ and coefficient of friction of leather on CI is 0.35. | BT-5 | Evaluate |
| 2 | Design a flat belt drive for a fan running at 360 rpm which is driven by a 10 kW at1440 rpm motor. The belt drive is open type and the distance between the pulley Centres is 2000 mm .The diameter of a driven pulley is 1 m. | BT-6 | Creating |
| 3 | Design a flat belt drive to transmit 20 kW at 720rpm. The centre distance is 3m and the speed ratio is 3. Diameter of rolling pulley is 1.2 m. | BT-6 | Creating |
| 4 | Design a flat belt drive to transmit 15 kW at 480rpm from an engine to line shaft at 1200 rpm. The Centre distance between the pulleys is 2m .The diameter of engine pulley is 600 mm. | BT-6 | Creating |
| 5 | A flat belt drive is required to transmit 12 kW from a motor running at 720 rpm. The belt is 12 mm thick and has mass density of 0.001 gm/mm3. Permissible stress in the belt not exceed 2.5 N/$mm^2$. Diameter of driving pulley is 250 mm whereas the speed of driven pulley is 240 rpm. The two shafts are 1.25 m apart, coefficient of friction is 0.25. Determine the width of the belt. | BT-6 | Creating |
| 6 | Design a suitable V-belt for a centrifugal pump running at 340 rpm is to be driven by 100 kW motor at 1440 rpm. The drive is to work at least 20 hours every day. Centre distance is 1.2 m. | BT-6 | Creating |
| 7 | Design a V-belt drive to transmit 10kW at 400 rpm. The speed ratio is 3. Centre distance between the pulleys is 600 mm and the drive is crusher. | BT-6 | Creating |

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| 8 | Design a V-belt drive and calculate the actual belt tension and average stress for the following data. Driven pulley diameter = 500 mm, driver pulley diameter, d=150 mm, center distance C=925 mm, speed $N_1$ = 1000 rpm, $N_2$ = 300 rpm and power, P = 7.5kW. | BT-6 | Creating |
| 9 | A centrifugal pump running at 340rpm is to be driven by a 100kW motor running at 1440rpm. The drive is to work for at least 20 hours every day. The centre distance between the motor shaft and the pump shaft is 2000mm. Suggest a suitable multiple V-belt drive for this application. Also calculate the actual belt tensions and stress induced. | BT-5 | Evaluate |
| 10 | A compressor is to run by a motor pulley running at 1440 rpm, speed ratio is 2.5. Choose a flat belt crossed drive. Centre distances between pulley is 3.6m take belt speed as 16m/s. Load factor is 1.3 and take 5 ply of flat belt. Power to be transmitted to be 12 kW. High speed load rating is 0.0118kW/Ply/mm width at V=5 m/s .Determine the width and length of the belt. | BT-5 | Evaluate |
| 11 | A truck equipped with 9.5 kW engine uses a roller chain of the final drive to the rear axle. The driving sprocket runs at 900 rpm and driven sprocket at 400 rpm with a center distance of approximately 600 mm. select a suitable the roller chain. | BT-6 | Creating |
| 12 | A roller chain drive is used between a driver shaft running at 1440 rpm and a driven shaft running approximately at 720rpm. The power transmitted is 15kW. The drive is to be used for 2 shift /day with 8 hours /shift. The center distance is approximately 1000 mm and the chain tension can be adjusted by moving the motor in the rails. Design the drive. | BT-6 | Creating |
| 13 | A work shop crank carries a load of 30 kN using wire ropes anda hook. The hook weighs 15 kN. Diameter of the rope drum is 30 times the diameter of the rope. The load is lifted with an accelerationof 1m/s$^2$. Find the diameter of the rope. FS = 6, $E_r$ =80 kN/mm$^2$,$\sigma_u$ = 180 kN/mm$^2$, cross section of the rope = 0.4x (Diameter of the rope) $^2$. Design wire rope with suitable assumption. | BT-6 | Creating |
| 14 | At the construction site, 1 ton of steel is to be lifted up to a height of 20 m with the help of 2 wire ropes of 6x 19 size, nominal diameter 12 mm and breaking load 78 kN. Determine the factor of safety if the sheave diameter is 56d and if wire rope is suddenly stopped inone second when travelling at a speed of 1.2 m/s. What is the factor of safety if bending load is neglected? | BT-5 | Evaluate |

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| 15 | Design a rubber belt to drive a dynamo generating 20 kW at 2250 r.p.m. and fitted with a pulley 200 mm diameter. Assume dynamo efficiency to be 85%. Allowable stress for belt = 2.1 MPa; Density of rubber = 1000 kg / $m^3$; Angle of contact for dynamo pulley = 165°; Coefficient of friction between belt and pulley = 0.3 | BT-5 | Evaluate |
| 16 | In a horizontal belt drive for a centrifugal blower, the blower is belt driven at 600 r.p.m. by a 15 kW, 1750 r.p.m. electric motor. The centre distance is twice the diameter of the larger pulley. The density of the belt material = 1500 kg/$m^3$; maximum allowable stress = 4 MPa; $\mu_1$ = 0.5 (motor pulley); $\mu_2$ = 0.4 (blower pulley); peripheral velocity of the belt = 20 m/s. Determine the following: 1. Pulley diameters; 2. belt length; 3. cross-sectional area of the belt; 4. minimum initial tension for operation without slip; and 5. resultant force in the plane of the blower when operating with an initial tension 50 per cent greater than the minimum value. | BT-6 | Creating |
| 17 | A V-belt is driven on a flat pulley and a V-pulley. The drive transmits 20 kW from a 250 mm diameter V-pulley operating at 1800 r.p.m. to a 900 mm diameter flat pulley. The centre distance is 1 m, the angle of groove 40° and $\mu$ = 0.2. If density of belting is 1110 kg /$m^3$ and allowable stress is 2.1 MPa for belt material, what will be the number of belts required if C-size V-belts having 230 $mm^2$ cross-sectional area are used. | BT-5 | Evaluate |
| 18 | Design a chain drive to actuate a compressor from a10 kW electric motor at 960 r.p.m. The compressor speed is to be 350 r.p.m. Minimum centre distance should be 0.5m. Motor is mounted on an auxiliary bed compressor is to work for 8 hours/ day. | BT-5 | Evaluate |

| PART C (15 Marks) | | | |
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| 1 | Design a flat belt drive to transmit 110 kW for a system consisting of two pulleys of diameters 0.9 m and 1.2 m respectively, for a centre distance of 3.6 m, belt speed of 20 m/s and coefficient of frictionis 0.3.There is a slip of 1.2% at each pulley and 5% friction loss at each shaft with 20% over load. | BT-6 | Creating |
| 2 | Designs a chain drive to actuate a compressor from a 12 kW electric motor at 900 rpm, the compressor begin 250 rpm, Minimum centre distance should be 1000 mm, the chain tension maybe adjusted by shifting the motor on rails. The compressor is to work 8 hour/day. | BT-4 | Analyzing |
| 3 | A 10 kW, 720 rpm motor is to drive a mixer at 180 rpm. The starting load is heavy and the service is intermittent. Select suitable drive and determine the main dimensions of the drive. | BT-1 | Understanding |
| 4 | Design a chain drive to actuate a compressor from 15 kW electric motor running at 1000 rpm, the compressor speed being 350 rpm. The minimum centre distance is 500 mm. The compressor operates 15 hours per day. The chain tension may be adjusted by shifting the motor. | BT-6 | Creating |
| 5 | Two shafts whose centres are 1 metre apart are connected by a V-belt drive. The driving pulley is supplied with 95 kW power and has an effective diameter of 300 mm. It runs at 1000 r.p.m. while the driven pulley runs at 375 r.p.m. The angle of groove on the pulleys is 40°. Permissible tension in 400 $mm^2$ cross-sectional area belt is 2.1 MPa. The material of the belt has density of 1100 kg / $m^3$. The driven pulley is overhung, the distance of the centre from the nearest bearing being 200 mm. The coefficient of friction between belt and pulley rim is 0.28. Estimate: 1. The number of belts required; and 2. Diameter of driven pulley shaft, if permissible shear stress is 42 MPa. | BT-6 | Creating |

## UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS

Speed ratios andnumber of teeth-Forceanalysis–Tooth stresses – Dynamic effects– Fatiguestrength – 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 (2 Marks)

| Q.No | QUESTIONS | BT Level | Competence |
|---|---|---|---|
| 1 | State the law of gearing. | BT-2 | Understanding |
| 2 | Name the profiles of spur gear. List the various methods of manufacturing gears. | BT-1 | Remembering |
| 3 | Describe the following (i) Pressure angle (ii) Diametral pitch | BT-2 | Understanding |
| 4 | Classify the gear based on position of teeth on wheel. | BT-1 | Remembering |
| 5 | Describe backlash. What factors influence backlash. | BT-2 | Understanding |
| 6 | What is meant by undercutting in gears? | BT-2 | Understanding |
| 7 | Define module. | BT-1 | Remembering |
| 8 | Classify the main types of gear tooth failure. | BT-1 | Remembering |
| 9 | Why dedendum value is more than addendum value? | BT-3 | Applying |
| 10 | List the materials commonly used for gears. | BT-1 | Remembering |
| 11 | Differentiate involute and cycloid profiles | BT-4 | Analyzing |
| 12 | Mention the advantages of nonmetallic gears. | BT-1 | Remembering |
| 13 | What is virtual number of teeth in helical gears? | BT-2 | Understanding |
| 14 | How number of teeth affects the design of gears? | BT-4 | Analyzing |
| 15 | Describe circular pitch. | BT-1 | Remembering |
| 16 | Identify the forces and stresses that act on spur gear tooth? Give their expressions. | BT-4 | Analyzing |
| 17 | Describe arc of contact on gear. | BT-1 | Remembering |
| 18 | State the advantages and disadvantages of helical and herringbone Gear. | BT-1 | Remembering |
| 19 | Define velocity ratio. | BT-1 | Remembering |
| 20 | What is effect of increasing pressure angle in gears? | BT-1 | Remembering |
| 21 | Why are gear drives superior to belt drives or chain drives? The advantages of gear drives? | BT-3 | Applying |
| 22 | Specify the types of gears-failures. | BT-1 | Remembering |
| 23 | What factors influence backlash? | BT-1 | Remembering |
| 24 | What is meant by a corrected gear? | BT-1 | Remembering |
| 25 | Define form factor? | BT-1 | Remembering |

| PART-B (13 Marks) | | | |
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| **Q.No** | **QUESTIONS** | **BT Level** | **Competence** |
| 1 | Design a pair of straight spur gear drive for a stone crusher, the gears are made of C40 steel. The pinion is to transmit 30 kW at 1200 rpm. The gear ratio is 3. The gear is to work 8 hours/day 6days in a week for 3 years. | BT-6 | Creating |
| 2 | Design a spur gear pair to transmit 22.5 kW at 900 rpm. Speed reduction ratio is 2.5. Material for pinion and wheel are C15 steel and cast iron grade 30 respectively. Take pressure angle 20 degree and working life of gear is 10,000 hours. | BT-6 | Creating |
| 3 | Design a spur gear drive required to transmit 45 kW at pinion speed of 800 rpm. The velocity ratio is 3.5:1. The teeth are 20 º full depths involute with 18 teeth on the pinion. Both the pinion and gear are made of steel with a safe static stress of 180 $N/mm^2$. Assume medium shock condition. | BT-6 | Creating |
| 4 | Design a straight spur gear drive to transmit 8 kW. The pinion speed is 720 rpm and the speed ratio is 2. Both the gears are made of the same surface hardened carbon steel with 55RC and core hardness less than 350BHN. Ultimate strength is 720 $N/mm^2$ and yield strength is 360 $N/mm^2$. | BT-6 | Creating |
| 5 | Design a spur gear to transmit 2 kW at 1440 rpm. Desired speed ratio is 3. Use C45 steel for gears. | BT-6 | Creating |
| 6 | A 37.5 kW power is transmitted at 450 rpm to a shaft running at approximately 112 rpm through a spur gear drive. The load is steady and continuous. Design the gear drive and check the design. Assume the following materials: Pinion-heat treated cast steel; Gear-High grade cast iron. | BT-6 | Creating |
| 7 | Design a spur gear drive for a heavy machine tool with moderate shocks. The pinion is transmitting 18 kW at 1200 rpm with a gear ratio of 3.5. Design the drive and check for elastic stress and plastic deformation. Make a sketch and label important dimensions arrived. | BT-6 | Creating |

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| 8 | A motor shaft rotating at 1500 rpm has to transmit 15kW to the shaft with a speed reduction of 3:1. The teeth are 20º involute with 25 teeth on the pinion. Both the pinion and gear are made of steel with a maximum safe stress of 200 $N/mm^2$. A safe stress of 40 $N/mm^2$ may be taken for the shaft on which the gear is mounted and also for the key. Design a spur gear drive and assume starting torque to be 25% higher than the running toque. | BT-6 | Creating |
| 9 | Design a helical gear to transmit 15 kW at 1440 rpm to the following specification. Speed reduction is 3, Pressure angle is 20 degree and helix angle is 15 degrees. The material for both the gears is C45 steel. Allowable static stress is 180 $N/mm^2$, Surface endurance limit is 800 $N/mm^2$ and Young's Modulus of material is $2 \times 10^5$ $N/mm^2$. | BT-6 | Creating |
| 10 | Design a helical gear for the following specification: Power-12.5kW, Pinion speed-1200 rpm, Gear Ratio - 3.5, Pressureangle is 20 degrees, helix angle is 15 degrees. Gear is expected to work 6hours/day for 10 years. | BT-6 | Creating |
| 11 | A helical gear with 30 º helix angle has to transmit 35kW at 1500 rpm with a speed reduction ratio 2.5. If the pinion has 24 teeth determine the necessary module, pitch diameter and face width for 20-degree full depth teeth. Assume 15Ni 2Cr 1 Mo15 material for both pinion and wheel. | BT-5 | Evaluate |
| 12 | A helical gear speed up drive is required to drive a centrifugal compressor running at 3000 rpm. The helical gear speed up unit is driven by an electric motor running at 1000rpm. The compressor requires a nominal input power of 12.5 kW. The helix angle of 250 may be assumed for the gears. Standard involute profile 20º full depth system will be used for the gear teeth. The gear pair is required to last for at least 10,000 hrs. Design the gear drive for the following materials. Pinion: Heat treated cast steel, Gear: High Grade cast iron. | BT-5 | Evaluate |

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| 13 | Design a pair of helical gears to transmit 37.5kW at 1750 rpm of the pinion. The drive is subjected to heavy shock loading. The speed reduction ratio is 4 and the helix angle is 15 degrees. Select suitable material and design the gears. Check for working stresses and sketch the drive. | BT-6 | Creating |
| 14 | Design a helical gear drive to transmit the power of 14.7kW. Speed ratio is 6, pinion speed is 1200 rpm and helix angle is 25º. Select suitable materials and design the gear. | BT-6 | Creating |
| 15 | A speed reducing unit using spur gear is to be designed power to be transmitted is 60HP and is continuous with moderate shock loads. The speed of the shafts are 720 r.p.m. and 144 r.p.m. The centre distance is kept as small as possible. Select a suitable material and design the gears. Give the details of gears. | BT-6 | Creating |
| 16 | Design a spur gear drive to transmitted 22 kW at 900 r.p.m. speed reduction is 2.5 material for pinion and wheel are C15 steel and cast iron grade 30. Take pressure angle of $20^o$ and working life of the gears as 10000 hours. | BT-6 | Creating |
| 17 | A pair of helical gears is to be designed to transmit 30 kW at a pinion speed of 1500 r.p.m. The velocity ratio is 3. Selecting suitable materials, determine the dimension of the gears. | BT-6 | Creating |
| 18 | Deign a helical gear drive to transmit the power of 20 HP. Speed ratio 6, pinion speed 1200 rpm, helix angle is $25^o$. Select suitable materials and design the gears. | BT-6 | Creating |

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| | **PART C (15 Marks)** | | |
| 1 | Design a pair of spur gear to transmit 20 kW at a pinion speed of 1440 rpm. The transmission ratio is 4. Assume 15Ni2Cr1Mo15 for pinion and C45 for gears. | BT-6 | Creating |

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| 2 | For intermittent duty of an elevator, two cylindrical gears made of alloys steel 40 Ni 2 Cr 1 Mo 28, and have to transmit12.5 kW at a pinion speed of 1200 rpm. Design a gear pair for the following specifications: Gear ratio: 3.5, pressure angle 20º, involute full depth, helix angle 15º. Gears are expected to work 6 hrs a day for 10 years. Minimum number of teeth on pinion can be taken as 20 and IS quality 8. | BT-5 | Evaluate |
| 3 | Design a pair of helical gears to transmit 10 kW at 1000 rpm of the pinion and wheel are made of C15 steel and cast iron grade 30 respectively. The pinion is to transmit 22 kW power at 900 rpm. The gear ratio is 2.5, take pressure angle of 20º and helix angle is 15º. The material for the both gears is NI2Cr1Mo28.Give details of drive in tubular form. | BT-6 | Creating |
| 4 | A speed reducing unit using spur gear is to be designed. Power to be transmitted is 60 hp and is continuous with moderate shaft loads. The speeds of the shaft are 720 rpm and 144 rpm. The centre distance is kept as small as possible. Select a suitablematerial and design the gears. Give the details of the gear. | BT-4 | Analysing |
| 5 | Design a helical gear drive to transmit a power of 15 kw at 1440 r.p.m. to the following specifications. Speed reduction is 3. Pressure angle is $20^o$, helix angle is $15^o$. The material is both gears is C45 steel allowable static stress is 180 $N/mm^2$. $E=2x10^5$ $N/mm^2$. | BT-4 | Analysing |

## 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 (2 Marks)

| Q.No | QUESTIONS | BT Level | Competence |
|---|---|---|---|
| 1 | Under what situation bevel gears are used. | BT-2 | Understanding |
| 2 | Write short notes on Crown gear and Miter gear. | BT-1 | Remembering |
| 3 | Mention two characteristics of hypoid gear. | BT-1 | Remembering |
| 4 | What is zerol bevel gear? | BT-2 | Understanding |
| 5 | Define back cone distance for a bevel gear. | BT-1 | Remembering |
| 6 | Define the following term ( i) Cone distance (ii) Face angle | BT-1 | Remembering |
| 7 | Illustrate reference angle? How is related to speed ratio of bevel gear? | BT-4 | Analyzing |
| 8 | List the advantages of and disadvantages of worm gear drive. | BT-1 | Remembering |
| 9 | Define nominal pitch of worm gear. | BT-1 | Remembering |
| 10 | State the difference between angular gear and miter gear. | BT-1 | Remembering |
| 11 | Describe in which gear drive self-locking is available. | BT-2 | Understanding |
| 12 | Describe irreversibility in worm gear. | BT-2 | Understanding |
| 13 | Why is the efficiency of worm gear drive comparatively low? | BT-2 | Understanding |
| 14 | List the difference between bevel gear formation and other types of gears. | BT-1 | Remembering |
| 15 | Summarize the helix angle of worm. | BT-2 | Understanding |
| 16 | Name the contact occurred between the worm and wheel. How this does differs from other gears? | BT-2 | Understanding |
| 17 | Differentiate between the spiral bevel gears and hypoid gears. | BT-4 | Analyzing |
| 18 | List the materials used for the manufacture of worm and worm and wheel. | BT-1 | Remembering |
| 19 | Why worm is made of harder material than worm wheel? | BT-4 | Analyzing |
| 20 | State the reason why crossed helical gear drive is not used for power transmission? | BT-4 | Analyzing |

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| 21 | What are the various forces acting on a bevel gear? | BT-2 | Understanding |
| 22 | When do we employ crossed helical gear? | | Remembering |
| 23 | Mention two characteristics of hypoid gear. | BT-2 | Understanding |
| 24 | Usually worm is made of hard material and worm gear is made of softer material – justify. | BT-4 | Analyzing |
| 25 | Define virtual or formative or equivalent number of teeth for bevel gears. | BT-1 | Remembering |

| PART-B (13 Marks) | | | |
|---|---|---|---|
| **Q.No** | **QUESTIONS** | **BT Level** | **Competence** |
| 1 | Design a pair of bevel gears to transmit 10 kW at 1440 rpm of the pinion. The velocity ratio should be about 4. Material for gear is 1 5 N i 2 C r 1M o 1 5 Steel. The tooth profiles of the gears are of 20 º composite form. | BT-6 | Creating |
| 2 | Design a cast iron bevel gear drive for a pillar drilling machine to transmit 1875 Watts at 800 rpm to a spindle at 400 rpm. The gear is to work for 40 hrs /week for 3 years. Pressure angle is 20º. | BT-6 | Creating |
| 3 | Design a Bevel gear drive to transmit 4 kW. Speed ratio = 4. Driving shaft speed 225 rpm. The drive is non-reversible. Assume a life of 25000 hours. | BT-6 | Creating |
| 4 | A Pair of bevel gears is to be used to transmit 14 kW from a pinion rotating at 400 rpm to a gear mounted on shaft which is running at 200 rpm. The axes of the two shafts are at 90°. Design the pair of bevel gears. | BT-5 | Evaluate |
| 5 | Design a pair of bevel gears for two shafts whose axes are at right angle to transmit 10 kW at 1440 rpm. The speed of the gear is 720 rpm. Use Lewis and Buckingham's equation. | BT-6 | Creating |
| 6 | Design a straight bevel gear drive between two shafts connected at right angles to each other. Speed of the pinion shaft is 360 rpmand the speed of gear wheel shaft is 120 rpm. Pinion is made of steel and wheel is made of cast iron. Each gear is expected to work 2 hrs /day for 10 years. | BT-6 | Creating |
| 7 | 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 drive if an efficiency of at least 82% is desired. | BT-6 | Creating |
| 8 | A steel worm running at 240 rpm receives 1.5 kW from its shaft. The speed reduction is 10:1. Design the drive so as to have an efficiency of 80%. Also determine the cooling area required, if the temperature rise is restricted to 450° C. Take overall heat transfer coefficient as 10 W/m$^2$°C. | BT-5 | Evaluate |
| 9 | Design the worm gear drive and determine the power loss by heat generation of Hardened steel worm rotates at 1440 rpm and transmits 12 kW to a phosphor bronze gear with gear ratio of 16. | BT-6 | Creating |

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| 10 | A hardened steel WORM rotates at 1260 rpm and transmits 8 kW to a phosphor bronze gear with gear ratio of 18. Design the worm gear drive and determine the power loss by heat generation. | BT-6 | Creating |
| 11 | Design a worm gear drive to transmit 22.5kW at a worm speed of 1440 rpm. Velocity ratio is 24:1. An efficiency of at least 85% is desired. The temperature raise should be restricted to 40°C Determine the required cooling area. | BT-6 | Creating |
| 12 | Design a bevel gear drive, to transmit 10 kW power at 1440 rpm. Gear ratio is 3, and life of gears 10,000 hrs. Pinion and gear are made of C45 steel and minimum number of teeth as 20. | BT-6 | Creating |
| 13 | A hardened steel work rotates at 1600 rpm and transmits 15 kW phosphor bronze gear. The speed of the worm wheel shouldbe 65 ± 2% rpm. Design a worm gear drive if an efficiency of at least 82% is desired. | BT-6 | Creating |
| 14 | Design a worm gear drive to transmit 22.5 kW at a worm speed of 1440 rpm. Velocity ratio is 24:1. An efficiency of at least 85% is desired. The temperature raise should be restricted to 40°C. Determine the required cooling area. | BT-5 | Evaluating |
| 15 | Design worm and gear speed reducer to transmit 22 kW at a speed of 1400 r.p.m. The desired velocity ratio is 24:1. An efficiency of atleast 85% is desired. Assume that the worm is made of hardened steel and the gear of phosphor bronze. Take the center distance as 100 mm. | BT-5 | Evaluating |
| 16 | A pair of cast iron bevel gears connected two shafts at right angles. The pitch diameters of the pinion and gear are 80mm and 100mm respectively. The tooth profile of the gears is of $14^{1/2o}$ and composite form. The allowable static stress for both gears is 55 Mpa. If the pinion transmits 2.75Kw at 1100 r.p.m. find the module and number of teeth on such gears and check the design. Take surface endurance limit as check the design. Take surface endurance limit as 630 Mpa and modulus of elasticity for cast iron as 84 $kN/mm^2$. | BT-5 | Evaluating |

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| 17 | A pair of bevel gears is to be used to transmit 12kW from a pinion rotation at 360 r.p.m. to a gear mounted on a shaft which intersects the pinion shaft at an angle of $70^o$.Assuming that the pinion is to have an outside pitch diameter of 200mm, a pressures angle of $20^o$, a face width of 40 mm and the gear shaft is to rotate at 120 r.p.m. determine (i) the pitch angle for the gears and (ii) the forces on the gears. | BT-5 | Evaluating |
| 18 | Design a worm gear drive to transmit 22.5 Kw at a worm speed of 1440 r.p.m. velocity ration is 24:1. An efficiency of atleast 85% is desired. The temperature rise should be restricted to $40^oC$. Determine the required cooling area. | BT-5 | Evaluating |

| PART C (15 Marks) | | | |
|---|---|---|---|
| 1 | Design a bevel gear to transmit 3.5 kW with driving shaft speed is 200 rpm. Speed ratio requires is 4. The drive is non- reversible. Pinion is made of steel and wheel made of CI. Assume a life of 25,000 Hrs. | BT-6 | Creating |
| 2 | Design a pair of right angled bevel gear to transmit 15kW at 750 rpm to another gear to run at 250 rpm. Not less than 20 teeth are to be used on either gear. The pressure angle is 20°. Assume a gear life of 12000 hrs. | BT-6 | Creating |
| 3 | 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 gear has 40 teeth with 5mm module. The pressure angle in the diametric plane is 20°.Determine (i) Lead angle of the worm (ii) Velocity ratio (iii) Centre distance. Also calculate the efficiency of worm gear drive and power lost in friction. | BT-5 | Evaluate |
| 4 | A pair of straight tooth bevel gears has a velocity ratio of 4/3. The pitch diameter of the pinion is 150 mm. The face width is 50mm. The pinion rotates at 240 rev/min. The teeth are 5mm module, 14° Involutes. If 6 kW is transmitted, determine (i) the tangential force at the Mean radius (ii) the pinion thrust force (iii) the gear thrust force. Draw the free body diagrams indicating the forces. | BT-5 | Evaluate |
| 5 | A pair of cast iron bevel gear connect two shafts at right angles. The pitch diameters of the pinion and gears are 80mm and 100 mm respectively. The tooth profiles of the gears are of $14^{1/2o}$ composite form. The allowable static stress for both the gears is 55 Mpa. If the pinion transmits 2.75kW at 1100 r.p.m. find the module and number of teeth on each gears and check the design for wear strength. Take surface endurance limit as 630 Mpa and modules of elasticity for cast iron as 84 $kN/mm^2$ | BT-6 | Creating |

| 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 reducerunit. – Variable speed gear box, Fluid Couplings, Torque Converters for automotive applications. | | | |
| **PART-A (2 Marks)** | | | |
| **Q.No** | **QUESTIONS** | **BT Level** | **Competence** |
| 1 | What are preferred Numbers? | BT-2 | Understanding |
| 2 | List any two methods used for changing speeds in gear box. | BT-1 | Remembering |
| 3 | Specify the four types of gear box. | BT-1 | Remembering |
| 4 | Define progression ratio. | BT-2 | Understanding |
| 5 | Compare sliding mesh and synchromesh gear box. | BT-2 | Understanding |
| 6 | What does the ray-diagram of gear box indicates? | BT-2 | Understanding |
| 7 | Differentiate Ray diagram and structural diagram. | BT-1 | Remembering |
| 8 | List the six speeds starting from 18 rpm with a step ratio of 1.4 | BT-2 | Understanding |
| 9 | Write the possible structural arrangements to achieve 6 speed gear box. | BT-5 | Evaluate |
| 10 | State three basic rules to be followed while designing a gear box. | BT-1 | Remembering |
| 11 | Sketch the kinematic layout of gears for 3 speeds between shafts. | BT-1 | Remembering |
| 12 | Write any two requirements of a speed gear box. | BT-2 | Understanding |
| 13 | List four applications where constant mesh gear box is used. | BT-2 | Understanding |
| 14 | Specify the function of spacers in a gear box. | BT-2 | Understanding |
| 15 | List the methods of lubrication in speed reducers. | BT-2 | Understanding |
| 16 | Find the step ratio for 12 speed gear box, the speed range of the gear box from 50 rpm to 600 rpm. | BT-5 | Evaluate |
| 17 | List the significance of structural formulas. | BT-1 | Remembering |
| 18 | Write the possible structural arrangements to achieve 12 speed gear box. | BT-1 | Remembering |
| 19 | Write the possible structural formula for 16 speed gear box. | BT-5 | Evaluate |
| 20 | Define torque converter. List its functions and applications. | BT-1 | Remembering |
| 21 | List out the basic rules to be followed for optimum gear box design | BT-1 | Remembering |
| 22 | Explain why the discrete speeds are specified in geometric series for any machine tools. | BT-2 | Understanding |
| 23 | What is the function of spacers in a gear box? | BT-2 | Understanding |
| 24 | Draw the Ray diagram for a 6speed Gear box. | BT-5 | Evaluate |
| 25 | Compare sliding mesh and synchromesh gear box. | BT-2 | Understanding |

| PART-B (13 Marks) | | | |
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| **Q.No** | **QUESTIONS** | **BT Level** | **Competence** |
| 1 | Design the six speed gear box is to provide the speeds in the range of 160 to 500 rpm and transmit a power of 5 kW at 710 rpm. Draw the speed diagram and kinematics diagram. Determine the number of teeth module and face width of all gears, assuming suitable Materials for the gears. | BT-6 | Creating |
| 2 | Design a 9 speed gear box for the following data. Minimum speed: 180 rpm, Maximum speed: 1800 rpm. Using standard step ratio, draw the speed diagram, kinematic layout. Also find the number of teeth on each gear. | BT-6 | Creating |
| 3 | 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. | BT-6 | Creating |
| 4 | Design 12 speed gear box for a minimum speed of 160 rpm and a maximum speed of 2000 rpm. The input speed of motor is 1600rpm. Draw the speed diagram, kinematic diagram and indicate the number of teeth on each gear. | BT-6 | Creating |
| 5 | Design the layout of a 12 speed gear box for a milling machine having an output of speeds ranging from 100 to 1200 rpm. Power is applied to the gear box from a 5 kW induction motor at 1440 rpm. Choose standard step ratio and construct the speed diagram. Decide up on the various reduction ratios and number of teeth on each gear wheel sketch the arrangement of the gear box. | BT-6 | Creating |
| 6 | Design the headstock gear box of a lathe having nine spindle speeds ranging from 50 to 1500 rpm. The power of the machine may be taken as 6 kW and speed of the motor is 1450 rpm. Minimum number of teeth on the gear is to be 2x3. (a) Draw the speed diagram (b) Sketch the layout of the gear box. (c) Calculate the number of teeth on all gears. | BT-6 | Creating |
| 7 | Illustrate the ray diagram and kinematic lay out of a gear box for an all geared head stock of a lathe. The maximum and minimum speeds are to be 2800 and 63 rpm respectively. The number of steps is 12 and drive is from a 3 kW electric motor running at 1440rpm. | BT-5 | Evaluating |

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| 8 | Select speeds for an 18 speeds Gear box for a minimum speed of 35 rpm and maximum speed 650 rpm. Draw speed diagram and a kinematic arrangement of the gear box showing the number of teeth in all the gears. | BT-6 | Creating |
| 9 | The spindle of a pillar drill is to run at 12 different speeds in the range of 100 rpm and 355 rpm. Design a three stage gear box with astandard step ratio. The gear box receives 5kW from an electric motor running at 360 rpm. Sketch the layout of the gear box, indicating the number of teeth on each gear. Also sketch the speed diagram. | BT-6 | Creating |
| 10 | Design a 16 speed gear box for the following data. Minimum speed: 100 rpm, step ratio is 1.25. The input is from a 5 kW, 1000rpm motor. Draw the speed diagram, kinematic diagram and indicate the number of teeth on each gear. | BT-6 | Creating |
| 11 | A 16 speed gear box is required to furnish output speeds in the range of 100 to 560 rpm. Sketch the kinematic arrangement and draw the speed diagram. | BT-6 | Creating |
| 12 | The range of maximum and minimum speeds of nine speed box are to be 600 rpm and 100 rpm respectively. The drive is from an electric motor giving 3kW at 1440rpm. Design the gear box. Construct the speed diagram and sketch the arrangement of gear box. | BT-6 | Creating |
| 13 | Design a six speed gear box for a machine to provide speeds ranging from 100 rpm to 560 rpm. The input shaft speed is 560rpm. The intermediate shaft to have three speeds. Assume any alloy steel for the gears. | BT-6 | Creating |
| 14 | Draw the ray diagram and kinematic lay out of a gear box for an all geared head stock of a lathe. The maximum and minimum speeds are to be 600 rpm and 23 rpm respectively. Number of step is 12 and drive is from a 3000 W electric motor running at 1440 rpm. | BT-6 | Creating |
| 15 | Write down all the possible structural formula for 6,8,9,12,14,15,16 & 18 speed gear box. | BT-2 | Understanding |
| 16 | Explain in detail the selection of standard speeds from preferred numbers using step ratio with suitable examples. | BT-2 | Understanding |

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| 17 | A nine speed gear box used as a head stock gear box of a turret lathe, is to provide a speed range of 180 r.p.m. Using standard steep ratio, draw the speed diagram and the kinematic layout. Also find and fix the number of teeth on all gears. | BT-6 | Creating |
| 18 | Design a 12 speed gear box for an all geared heat stock of a lathe. Maximum and minimum speeds are 600 r.p.m. and 25 r.p.m. respectively. The drive is from an electric motor giving 2.25kW at 1440 r.p.m. | BT-6 | Creating |

| PART C (15 Marks) | | | |
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| | A six speed gear box is required to provide output speeds in the range of 125 to 400 rpm with a step ratio of 1.25 and transmit a power of 5 kW at 710 rpm. Draw the speed diagram and kinematics diagram. Determine the number of teeth module and face width of all gears, assuming suitable materials for the gears. Determine the length of the gear box along the axis of the gear shaft. | BT-3 | Applying |
| 2 | A machine tool gear box is to have 9 speeds. The gear box is driven by an electric motor whose shaft rotational speed is 1400 rpm. The gear box is connected to the motor by a belt drive. The maximum and minimum speeds required at the gear box output are 1000 rpm. and 200 rpm respectively. Suitable speed reduction can also be provided in the belt drive. What is the step ratio and what are the values of 9 speeds? Sketch the arrangement. Obtain the number of teeth on each gear and also the actual output speeds. | BT-4 | Analyzing |
| 3 | In a milling machine, 18 different speeds in the range of 35 rpm and 650 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 n each gear. The gear box receives 3.6 kW from an electric motor running at 1,440 rpm. Sketch also the speed diagram. | BT-6 | Creating |
| 4 | Sketch the arrangements of a six speed gear box. The minimum and maximum speeds required are around 460 and 1400 rpm. Drove speed is 1440 rpm. Construct speed diagram of the gear box and obtain various reduction ratios. Use standard output speeds and standard step ratio. Calculate number of teeth in each gear and verify whether the actual output speeds are within + 2% of standard speeds. | BT-6 | Creating |
| 5 | A nine speed gear box used as a head stock gear box of a turret lathe, is to provide a speed range of 180 r.p.m. Using standard steep ratio, find and fix the number of teeth on all gears and calculate the percentage deviation of the obtainable speeds from the calculated ones. | BT-6 | Creating |

| UNIT V CAMS, CLUTCHES AND BRAKES | | | |
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| 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 (2 Marks)** | | | |
| **Q.No** | **QUESTIONS** | **BT Level** | **Competence** |
| 1 | Describe the working principle of clutch. | BT-1 | Remembering |
| 2 | List the significance of pressure angle in cam design. | BT-1 | Remembering |
| 3 | Define Jerk. Name the profile of the cam that gives no Jerk. | BT-1 | Remembering |
| 4 | Define pitch point in a cam. | BT-2 | Understanding |
| 5 | Name four profiles normally used in cams. | BT-1 | Remembering |
| 6 | Describe the term undercutting in cam. | BT-2 | Understanding |
| 7 | Classify the clutch by the method of its engagement. | BT-2 | Understanding |
| 8 | | BT-1 | Remembering |
| 9 | Name a few commonly used friction materials. | BT-1 | Remembering |
| 10 | Specify the desirable properties of friction materials in clutch. | BT-2 | Understanding |
| 11 | Give examples of axial and radial friction clutches. | BT-2 | Understanding |
| 12 | If a multidisc clutch has 6 discs in the driving shaft and 7 disc in the driven shaft and find the number of contact surfaces. | BT-5 | Evaluating |
| 13 | Clutches are usually designed on the basis of uniform wear.Why? | BT-4 | Analyzing |
| 14 | Quote the types of brake linings. | BT-1 | Remembering |
| 15 | What you meant by self-energizing brake? | BT-2 | Understanding |
| 16 | List out the bonding materials used to fabricate the frictional materials used in clutch. | BT-1 | Remembering |
| 17 | Differentiate between uniform pressure and uniform war theories adopted in design of clutches. | BT-2 | Understanding |
| 18 | What is meant by self-locking brake? | BT-2 | Understanding |
| 19 | Write the formula for torque transmitted by multi plate clutch. | | Evaluating |
| 20 | Why semi-cone angle is normally taken as 12.5° in cone clutch? | BT-4 | Analyzing |
| 21 | List at least four characteristics of the materials used for the brake linings. | BT-1 | Remembering |
| 22 | Define base circle, pitch circle and jerk with respect to cam. | BT-2 | Understanding |
| 23 | When do we use multiple disk clutches? | BT-2 | Understanding |
| 24 | What is fade? | BT-2 | Understanding |
| 25 | What are the factors upon which the torque capacity of a clutch depends? | BT-2 | Understanding |

| PART-B (13 Marks) | | | |
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| **Q.No** | **QUESTIONS** | **BT Level** | **Competence** |
| 1 | A single plate sketch, effective on both sides, is required to transmit 25kW at 3000 rpm. Determine the outer and inner diameter of frictional surfaces if the coefficient of friction is 0.25, ratio of diameter is 1.25 and the maximum pressure is not to exceed the value of 0.1 N/mm2. Determine (i) the face width required and (ii) the axial spring force necessary to engage the clutch. | BT-5 | Evaluate |
| 2 | 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 spring are used. | BT-5 | Evaluate |
| 3 | A multi disk clutch consists of five steel plates and four bronze plates. The inner and outer diameters of friction disks are 75mm and 150mm respectively. The coefficient of friction is 0.1 and the intensity of pressure is limited to 0.3. $N/mm^2$. Assuming the uniform wear theory, calculate (i) The required operating force, and (ii) Power transmitting capacity at 750 rpm. | BT-5 | Evaluate |
| 4 | A plate clutch has 3 discs on the driving shaft and 2 discs on the drive shaft, providing 4 pairs of contact surfaces. The outer diameter of contact surface is 240mm and inner diameter is120mm.Assuming uniform pressure and μ =0.3, find the total spring load forpressing the plates together to transmit 25kW at 1575 rpm. If there are 6 springs each of stiffness 13kN/m and each of contact surfaces have worn away by1.25mm, find the power that can be transmitted, assuming uniform wear. | BT-5 | Evaluate |
| 5 | A multi disc wet clutch is to be designed for a machine tool driven by an electric motor of 12.5 kW running at 1440 rpm. Space restrictions limit the outside disc diameter to 100mm. Determine the appropriate value of inside diameter, total number of discs and clamping force. | BT-5 | Evaluate |

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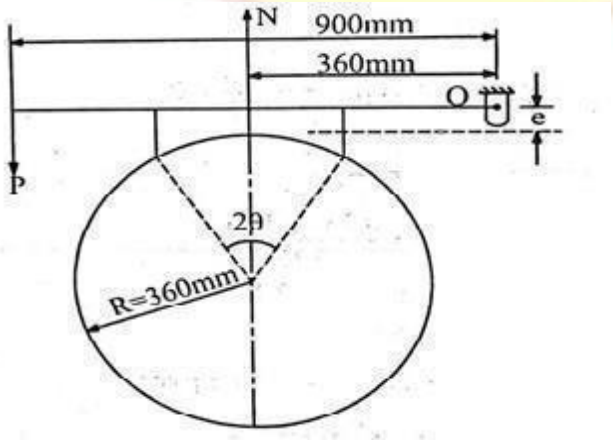
| 6 | An engine developing 45kW at 1000 rpm id fitted with a cone clutch built inside the fly wheel. The cone has a face angle of 12.5 degree and a maximum mean diameter of 500 mm. The coefficient of friction is 0.2. The normal pressure on the clutch face is not exceeded 0.1N/mm$^2$. Determine (i) The face width required (ii) the axial spring force necessary to engage the clutch. | BT-5 | Evaluate |
| 7 | A single block brake, the diameter of drum is 250mm and the angle of contact is 90 degrees, the operating force of 700N is applied at the end of lever which is at 250mm from the center of the brake block. Determine the torque that may be transmitted. Fulcrum is at 200mm from the center of brake block with an offset of 50mm from the surface of contact. The coefficient of friction is 0.35. | BT-5 | Evaluate |
| 8 | A 360 mm radius Brake drum contacts a single shoe as shown in Figure-1 and resists a torque of 250 Nm at 500 rpm.<br>The co- efficient of friction is 0.3.<br>Determine<br>(i) The normal reaction on the shoe,<br>(ii) The force to be applied at the lever end for counter clock Wise rotation of the drum if e= 0,<br>(iii) The force to be applied at the lever end for clock Wise rotation of the drum if e=42 mm,<br>(iv) The force to be applied at the lever end for counter clock Wiserotation of the drum if e = 42 mm.<br>  <br><br>**Fig-1** | BT-5 | Evaluate |

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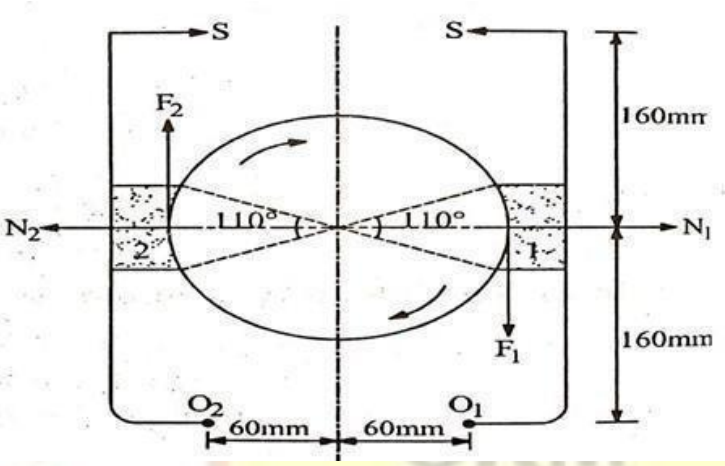
| 9 | The layout of a double block brake is shown in figure -2. The brake is rated at 250N-m at 650rpm. The drum diameter is 250mm.assuming the co-efficient of friction as 0.3 and for conditions of service a pV value of 1000 (KPa) m/s may be assumed. Determine (i) The spring force "S" required to set the brake (ii) Width of shoes (iii) Which shoe will have greater rate of wear?<br>  <br><br>**Fig-2** | BT-5 | Evaluate |
| 10 | An internal expanding shoe brake has the following dimensions: Diameter of the drum = 300 mm, distance between the fulcrum centers is 80 mm, distance of fulcrum centers and that of cam axis, both from the drum center=100 mm, distance of the line of action of braking force from the cam axis = 90 mm, distance between the points where the cam acts on the two brake shoes = 30 mm. Each shoe subtends an angle of 90° at the drum Centre. If the braking force is 750 N and the coefficient of friction is 0.3, Find the brakingtorque on the drum. Assume the reaction between the brake shoes and the drum passes through the point bisects the contact angle. Also assume that forces exerted by the cam ends on the two shoes are equal. | BT-5 | Evaluate |
| 11 | A power of 20 kW is to be transmitted through a cone clutch at 500 rpm. For uniform wear condition find the main dim of clutch and shaft. Also determine the axial force required to engage the clutch. Assume coefficient of friction as 0.25, the max normal pressure on the friction surface is not to exceed 0.08 MPa and take the design stress for the shaft material as 40 MPa. | BT-5 | Evaluate |

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| 12 | Design a differential band for a winch lifting a load of 20 kN through a steel wire rope wound around a barrel of 600 mm diameter. The brake drum, keyed to barrel shaft is 800 mm diameter and the angle of lap of the band over the drum is about 240 degree. Operating arms of the brake are 50 mm and 250 mm. The length ofoperating level is 1.6m. | BT-6 | Creating |
| 13 | Derive the expression to determine the braking torque for an internal expanding shoe brake. | BT-2 | Understanding |
| 14 | An automobile engine has an output of 80 kW at 3000 rpm. The mean diameter of the clutch is 200 mm with a permissible pressure of 0.2 $N/mm^2$. Friction lining is of asbestos with $\mu = 0.22$. What should be the inner diameter of the disc? Take both sides of plates with friction lining as effective. There are 8 springs and axial deflection in spring is limited to 10 mm. Given G = 80 $kN/mm^2$. Spring index may be taken as 6. | BT-5 | Evaluate |
| 15 | A plate clutch having a single driving plate with contact surfaces on each side is required to transmit 110 kW at 1250 r.p.m. The outer diameter of the contact surfaces is to be 300 mm. The coefficient of friction is 0.4. (a) Assuming a uniform pressure of 0.17 $N/mm^2$; determine the inner diameter of the friction surfaces. (b) Assuming the same dimensions and the same total axial thrust, determine the maximum torque that can be transmitted and the maximum intensity of pressure when uniform wear conditions have been reached. | BT-5 | Evaluate |
| 16 | A single dry plate clutch is to be designed to transmit 7.5 kW at 900 r.p.m. Find :1. Diameter of the shaft, 2. Mean radius and face width of the friction lining assuming the ratio of the mean radius to the face width as 4, 3. Outer and inner radii of the clutch plate, and 4. Dimensions of the spring, assuming that the number of springs are 6 and spring index = 6. The allowable shear stress for the spring wire may be taken as 420 MPa. | BT-5 | Evaluate |

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| 17 | A multiple disc clutch, steel on bronze, is to transmit 4.5 kW at 750 r.p.m. The inner radius of the contact is 40 mm and outer radius of the contact is 70 mm. The clutch operates in oil with an expected coefficient of 0.1. The average allowable pressure is 0.35 $N/mm^2$. Find: 1. the total number of steel and bronze discs; 2. the actual axial force required; 3. the actual average pressure; and 4. the actual maximum pressure. | BT-5 | Evaluate |
| 18 | A multi-disc clutch has three discs on the driving shaft and two on the driven shaft. The inside diameter of the contact surface is 120 mm. The maximum pressure between the surface is limited to 0.1 $N/mm^2$. Design the clutch for transmitting 25 kW at 1575 r.p.m. Assume uniform wear condition and coefficient of friction as 0.3. | BT-5 | Evaluate |

| | **PART-C (15 Marks)** | | |
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| 1 | A leather faced conical clutch has cone angle of 30°.The pressure between the contact surfaces is limited to 35$N/mm^2$ and the breath of the conical surface is not to exceed 1/3 of the mean radius. Find the dimensions of the contact surface to transmit 22kW at 2000 rpm Also calculate the force required to engage the clutch. Take $\mu$ =0.1 | BT-5 | Evaluate |
| 2 | A single plate clutch, both side being effective is required to connect a machine shaft to a driver shaft which runs at 500rpm. The moment of inertia of the rotating parts of the machine is $1Kgm^2$. The inner and the outer radii of the friction discs are 50mm &100mm respectively. Assuming uniform pressure of 0.1$N/mm^2$ and $\mu$ =0.25, determine the time taken for the machine to reach full speed when the clutch is suddenly engaged. Also determine the powertransmitted by the clutch and energy dissipated during the clutch slip and the energy supplied to the machine during engagement. | BT-5 | Evaluate |
| 3 | A radial cam rotates at 1200 rpm with the follower rising 20 mm with SHM in 1500 of the cam rotation. The roller is 32 mm in diameter and the prime circle is 80mm in diameter. Check whether undercutting will occur. | BT-5 | Evaluate |

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| 4 | A multi – disk clutch consists of five steel plates and four bronze plates. The inner and outer diameters of friction disks are 75mm and 150mm respectively. The coefficient of friction is 0.1 and the intensity of pressure is limited to 0.3 N/mm $^2$. Assuming the uniform wear theory, calculate (i) the required operating force, and (ii) power transmitting capacity at 750 rpm. | BT-5 | Evaluate |
| 5 | A centrifugal clutch is to be designed to transmit 15 kW at 900 r.p.m. The shoes are four in number. The speed at which the engagement begins is 3/4th of the running speed. The inside radius of the pulley rim is 150 mm. The shoes are lined with Ferro do or which the coefficient of friction may be taken as 0.25. Determine: 1. mass of the shoes, and 2. size of the shoes. | BT-5 | Evaluate |