EX/PROD/PC/B/T/324/2022

SUBJECT CODE: PROD/PC/B/T/324

B.PRODUCTION ENGINEERING EXAMINATION, 2022

(3rd Year, 2nd Semester)

DESIGN OF ENGINEERING SYSTEM-II

Time: 3 hrs. **Full marks: 100.**

(Attempt 30 marks from question No-1.)

1.	(a)	What is **miter gear**?	**(2)**
	(b)	What are the **applications of ribbed V-belts/ synchronous belts/ tooth belts.** ?	**(2)**
	(c)	What is notch sensitivity factor?	**(2)**
	(d)	What is **S-N curve**?	**(2)**
	(e)	What are the objectives of series and parallel connections of springs ?	**(2)**
	(f)	What is notch sensitivity factor?	**(2)**
	(g)	Define dynamic load carrying capacity of rolling contact bearing?	**(2)**
	(h)	What is **Crown gear**? Show with neat sketch.	**(2)**
	(i)	What is **creep** in belts?	**(2)**
	(j)	What are the methods of reducing stress concentration?	**(2)**
	(k)	What is the relationship between **actual and virtual number** of teeth and the **pitch angle** in bevel gears?	**(4)**
	(l)	Explain the terms with neat sketches (i) base circle (ii) pressure angle	**(4)**
	(m)	Why **tangential** component of gear tooth force is called 'useful' component and **radial** component is called separating component?	**(4)**
	(n)	What is **Crown gear**? Show with neat sketch.	**(4)**

(o) Sketch neatly when two bevel gears in mesh and show the **various forces acting on** it. **(4)**

(p) What is the difference between herringbone and double helical gears? State two advantages of these gears. **(4)**

(q) What are 'L_{10}' and '$L_{10}h$'? Find the relation between them. **(4)**

(r) **Find the relation between** dynamic load capacity and equivalent dynamic load. **(4)**

(s) **Discuss** the design procedure of spur gear/bevel gears. **(10)**

(t) Discuss the design procedure of a centrifugal clutch. **(10)**

2. A cantilever beam made of cold drawn carbon steel of circular cross-section as shown in ***FIGURE -1***. is subjected to a load which **varies from -F to 3F.** Determine the maximum load that this member can withstand for an indefinite life using **factor of safety as 2.** The **theoretical stress concentration factor** is **1.42** and the **notch sensitivity is 0.9.** assuming the following values :

Ultimate stress : 550 N/mm², yield stress : 470 N/mm²
Endurance limit : 275 N/mm², size factor : 0.85
Surface finish factor : 0.89. **(20)**

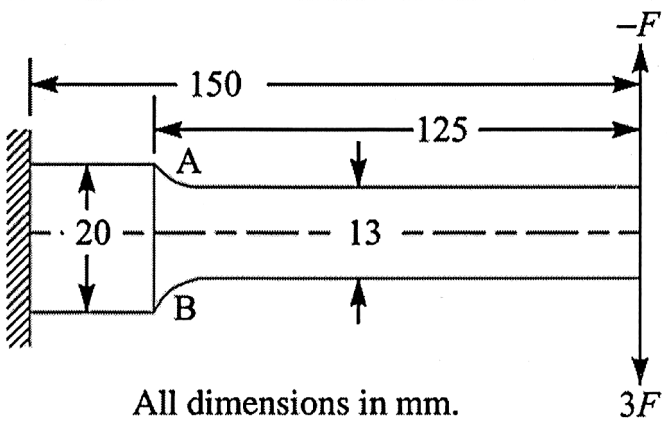


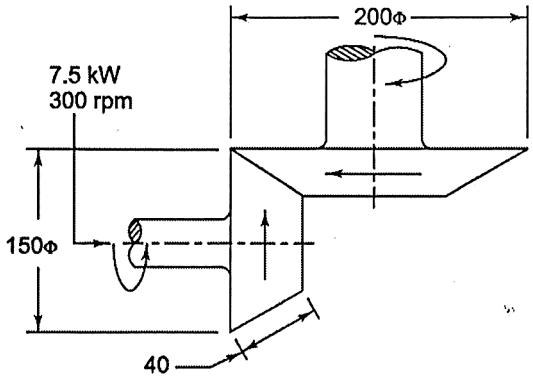
FIGURE -1.

3. Design a helical spring for a spring loaded safety valve for the following conditions:
Diameter of valve seat = **65 mm**; operating pressure = **0.7 N/ mm²;**
Maximum pressure when the valve blows off freely = **0.75 N/ mm²;**
Maximum lift of the valve when the pressure rises from 0.7 to 0.75 N/ mm² = **3.5 mm**; Maximum allowable stress = **550 N/mm²;**
Modulus of rigidity = **84 kN/mm²;** Spring index = **6.**
Draw a neat sketch of the free spring showing the main dimensions. **(20)**

4. A single dry plate clutch is to be designed to transmit **7.5 kW** at **900 rpm.** Find:
   (i) Diameter of the shaft,
   (ii) Mean radius and face width of the friction lining assuming the ratio of the mean radius to the face width as **4.**
   (iii) Outer and inner radii of the clutch plate,
   (iv) Dimension of the spring, assuming that the number of springs are **6** and spring index = **6.**
   Given: allowable shear stress for the spring wire = **420 N/mm².** **(20)**

5. A pair of straight teeth spur gears having **20°** involute full depth teeth is to transmit **12 kW** at **300 r.p.m.** of the pinion. The speed ratio is **3:1.**
The allowable static stress**(σ_o)** for gear of cast iron and pinion of steel are **σ_{oG} = 60 N/mm²** and **σ_{oP} = 105 N/mm²** respectively.
Assume the following:
Number of teeth of pinion **(Tp) = 16 T**; Face width **(b) = 14m**;
Velocity factor**(Cv) = 4.5/(4.5+ v),** v =the pitch line velocity in m/sec;
and Lewis form factor**(y) = (0.154 - 0.912)/T.** Given: Young's modulus for pinion and gear material are **Ep = 200 kN/mm², Eg = 100 kN/mm².**
Determine: (i) the module,
   (ii) face width ,
   (iii) pitch diameter of gears.
   (iv) check the gears for wear;
   (v) draw the dimensional sketch of the gears. **(25)**

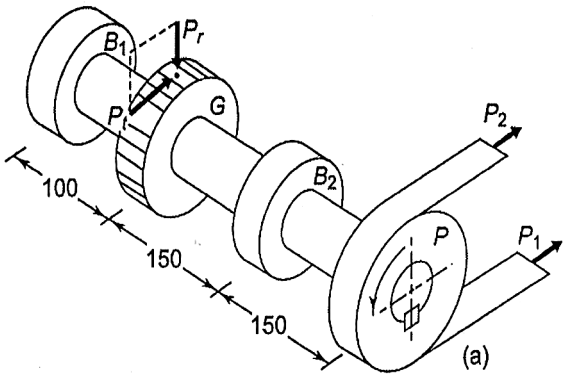
6. A pair of bevel gears transmitting **7.5 kW** at **300 rpm** is shown in **FIGURE-2.** The pressure angle(**ϕ**) = **20°'. Determine** the **component of tooth force** and **draw a free-body diagram** of forces acting on the pinion and the gear. **(25)**



(All dimensions are in mm)

FIGURE-2.

7. A transmission shaft rotating at **720 rpm** and transmitting power from pulley **'P'** to Spur gear **'G'** as shown in **FIGURE-3.** The belt tensions and the gear toot forces are given below :
P_1 = 498 N , P_2 = 166 N and
Pt =497 N, P_r = 181 N;
The weight of the pulley is **100 N**. The diameter of the shaft at bearings **'B_1'** and **'B_2'** are **ϕ10mm** and **ϕ20mm**. The **load factor = 2.5** and the expected life for **90%** of the bearings is **8000 hrs. select** the single-row deep groove ball bearing at **'B_1'** and **'B_2'**.
Given: Four different bearings Numbers are available for shaft diameter **ϕ10 mm** are **61800, 6000, 6200** and **6300** for dynamic load capacity(C): **1480 N, 4620 N, 5070 N** and **8060 N.**
Six different bearing are available for shaft diameter **ϕ20 mm** are **61804, 16404, 6004, 6204, 6304** and **6404** for dynamic load capacity(C) : **2700 N, 7020 N, 12700 N, 15900 N** and **30700 N.** **(25)**



(All dimensions are in mm)

FIGURE-3.

8. A motor shaft rotating at **1500 rpm** has to transmit **15 kW.** to a low speed shaft with a speed reduction of **3:1.** The teeth are **$\phi = 14.5^{o}$** involute with **25 T** on the pinion . Both the pinion and gear are made of steel with a maximum safe stress of **200 N/mm²**. A safe stress of **40 N/mm²** may be taken for the shaft on which the gear is mounted and for the key.
Assume starting torque be **25%** higher than the running torque.
Given : Gear module(m) = **8 mm;**
Service factor(S) = **1 for 8hrs. to 10 hrs.;**
Velocity ratio(v) = **3/(3+v), Upto 12.5 m/s;**
The tooth form factor **Y = 0.124 – 0.684/Tp;**
Pinion centre overhung on the shaft from bearing centre = **100 mm;**
Cs =1 for steady load condition and 8 to 10 hrs of service per day.
Design : (i) Spur gears;
(ii) Pinion shaft;
(iii) Gear shaft
(iv) Dimensional sketch of this drive. **(30)**

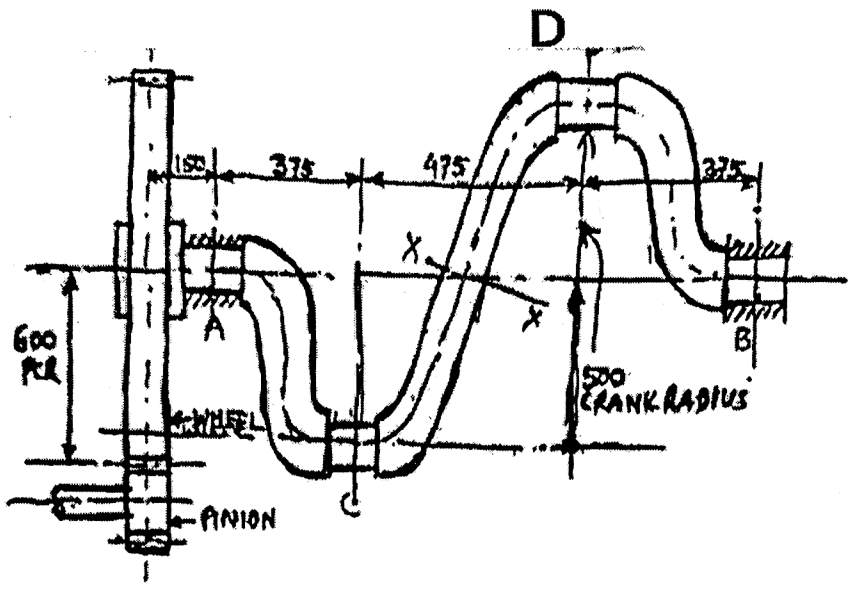
9. A pair of **20^{o}** full depth involute teeth bevel gears connect two shafts at right angles having velocity ratio **3:1.** The gear is made of cast steel having allowable stress as (σg)= **70 N/mm²** and pinion is steel with allowable stress is (σp) = **100 N/mm².** The pinion transmit s **37,5 kW** at **750 r.p.m.**
Given: tooth form factor **y = 0.154 - 0.912/TE ,**
where **TE** is the formative number of tooth,
Width = **1/3 X (length of pitch cone(Ao),**
the pinion shaft overhungs by **150 mm.**
Determine: (i) module(m) and face width(b);
(ii) pitch diameter of pinion and gear;
(iii) pinion shaft diameter;
(iv) wear load(Ww);
(v) dynamic load(Wd). **(30)**

10. Power of **60 kW** at **750 rpm** is to be transmitted from an electric motor to compressor shaft at **300 rpm** by **V-belt.** The approximate larger pulley diameter is **ϕ1500 mm.** The approximate centre distance is **1650 mm** and over load factor is to be taken **1.5.**
Given : belt cross-sectional area = **350 mm²;**
Density of belt material = **1000 Kg/m³;**
Allowable tensile stress for belt = **2 N/mm²;**
Co-efficient of friction(**μ**) between belt and the pulley = **0.28;**
The centre distance of driven pulley from nearest bearing centre = **300 mm;**
Shaft having permissible shear stress = **40 N/mm²;**
Standard (**As per IS; 2494-1974**) inside length of '**D' type** V-belt = **6807 mm;**
Pitch length of V-belt = **6886 mm;**
Standard key size for shaft diameter ϕ80 mm = **25X14 mm²;**
Give a complete design of :

(i) The **V-belt drive;**
(ii) Shaft;
(iii) V-grooved pulley;
(iv) Key. **(30)**

11. The **plan view** of a **two throw crank shaft** is shown in **FIGURE – 4.**
The pump **crank shaft** is made from a **single round steel bar.** The pumps are **single acting** and the **connecting rods** are assumed to be at **right angles (downwards)** to the **crank pins C and D.** For the **position shown, pump D** is **lifting** a total **downward load of 2500 Kg.** The load at the same instant **at C is 500 Kg. (downwards)** due to **dead weights** of the moving parts only.
Determine:-

(i) The **driving force** on **spur- pinion** and the **bearing reactions;**
(ii) Bending moment and **twisting moment** on **bearing A and B** and **pins C and D** and their **respective diameters** required for an allowable shear stress of **4.2 N/mm²;**
(iii) Maximum shear stress at **section X-X** due to **combined bending** and **twisting moments,** taking the **diameter** of the **round bar** to its nearest **stock size 1.2d,** where '**d**' is the diameter of the largest journals. **(40)**



(All dimensions are in mm)

FIGURE-4.