Roll No.									

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem 2019-20
Course Code: MEC 210
Course Name: DESIGN OF MACHINE ELEMENTS I
Program & Sem: B.Tech (MEC) & V

Date: 30.09.2019
Time: 11.00AM TO 12.00PM
Max Marks: 40
Weightage: 20%

Instructions:

(i) Read the questions properly and answer accordingly
(ii) Question paper consists of 3 parts
(iii) Scientific and Non programmable calculators are permitted,
(iv) Data hand book is permitted

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries five marks. (4Qx5M=20M)

1. State maximum principal stress theory of failure and show the boundary of maximum principal stress theory under bi-axial stresses.
(C.O.NO.1) [Comprehension]

2. Define the following terms [2+3M]
   a) Factor of safety
   b) What is S-N curve. Explain with diagram.
(C.O.NO.2) [Knowledge]

3. Explain with stress-time curve for different types of stress cycle for fatigue load.
(C.O.NO.2) [Comprehension]

4. A round shaft made of a brittle material and subjected to a bending moment of 15 N-m is shown in Fig.1. The stress concentration factor at the fillet is 1.5 and the ultimate tensile strength of the shaft material is 200 N/mm2. Determine the diameter d, the magnitude of stress at the fillet and the factor of safety.
(C.O.NO.1) [Comprehension]

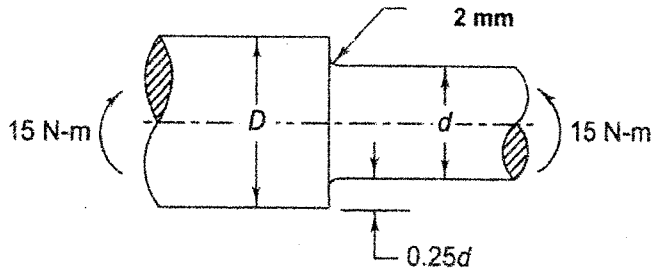


Fig.1

Part B [Thought Provoking Questions]

Answer the Question. The Question carries ten marks. **(1Qx10M=10M)**

5. Girder bridges are the simplest bridge type in structure and consist of steel beams shaped to an I-section, called a plate girder bridge. These steel beams are made of hot rolled steel (20C8) in form of rods and placed horizontally which is act as a cantilever beam as shown in Fig2(a). This cantilever beam (S_{ut} = 540 N/mm^2) is subjected to a completely reversed load of 1000 N as shown in Fig.2(b). The notch sensitivity factor q at the fillet can be taken as 0.85 and the expected reliability is 90%. Determine the diameter of the beam for a life of 10000 cycles.

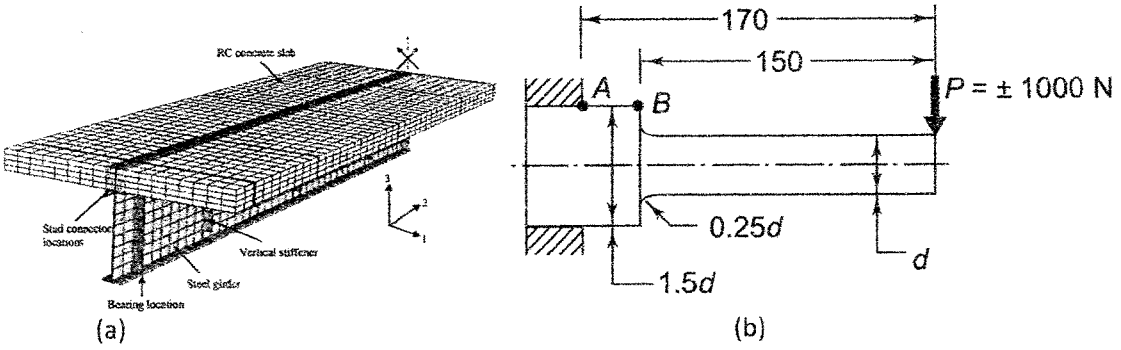


Fig.2

(C.O.NO.2) [Application]

Part C [Problem Solving Questions]

Answer the Question. The Question carries ten marks. **(1Qx10M=10M)**

6 . The shaft of an overhang crank subjected to a force 'P' of 1 kN is shown in Fig.3. The shaft is made of plain carbon steel 45C8 and the tensile yield strength is 380 N/mm^2. The factor of safety is 2. Determine the diameter of the shaft using the maximum shear stress theory.

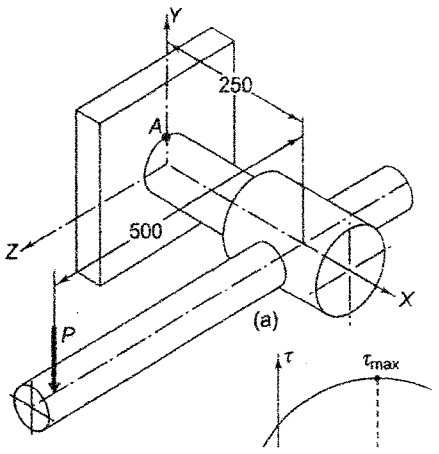


Fig.3

(C.O.NO.1) [Application]

SCHOOL OF Engineering

Semester: V

Course Code: MEC 210

Course Name: Design of Machine Elements I

Date: 30-09-2019

Time: 1 hour

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
	1	I/ Theories of failure & Stress concentration		5	C							5
2.	1 and 2	I/II/ Theories of failure & Stress concentration/ Design for Fatigue Load		5	K							5
3.	2	II/ Design for Fatigue Load		5	C							5
4.	1	I/ Stress concentration		5	C							5
5.	2	II/ Design for Fatigue Load					10	A				10
6.		I/ Theories of failure & Stress concentration								10	A	10
	Total Marks			20	C		10	A		10	A	40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

[I hereby certify that All the questions are set as per the above guide lines. Dr Bhaskar Pal]

Reviewers' Comments

SCHOOL OF ENGINEERING

SOLUTION

Semester: V

Course Code: MEC 210

Course Name: Design of Machine Elements I

Date: 30-09-2019

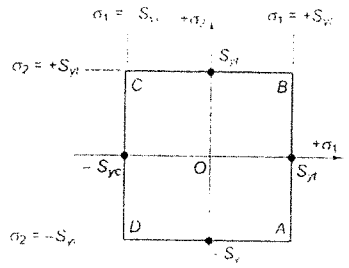
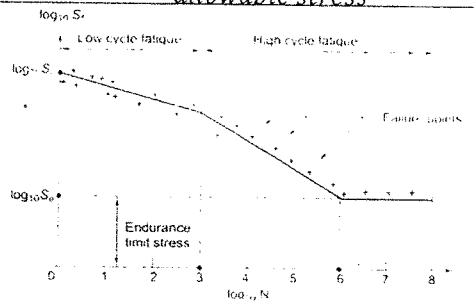
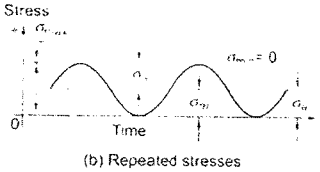
Time: 1 hour

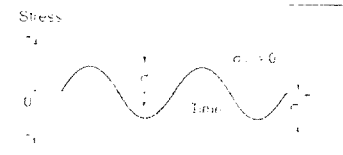
Max Marks: 40

Weightage: 20%

Part A

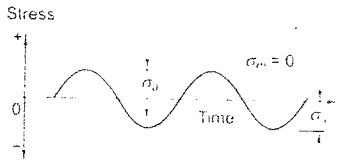
(4Q x 5M = 20Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	The theory states that the failure of the mechanical component subjected to bi-axial or tri-axial stresses occurs when the maximum principal stress reaches the yield or ultimate strength of the material. 	2 3	6
2 a)	While designing a component, it is necessary to provide sufficient reserve strength in case of an accident. The factor of safety is defined as $fs = \frac{failure\ stress}{allowable\ stress}$	2	4
b)		3	4
3	 (b) Repeated stresses	5	6



(c) Reversed stresses

Fig. 5.15



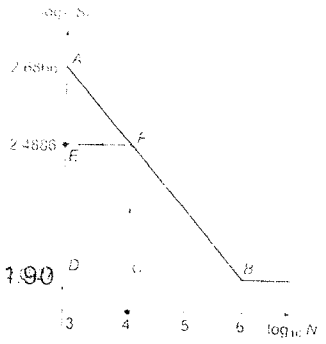
(c) Reversed stresses

4	$D = 0.25d + d + 0.25\,d = 1.5\,d$ $\left[\frac{D}{d} = 1.5\right]$ From Fig.5.5, (D/d = 1.5 and K_t = 1.5) $\left[\frac{r}{d} = 0.17\right]$ $d = \frac{1}{0.17} = \frac{2}{0.17} = 11.76$ mm $\sigma_b = \frac{32\,M_b}{\pi d^3} = \frac{32(15\times10^3)}{\pi (11.76)^3} = 93.94$ N/mm^2 $\sigma_{max} = K_t\,\sigma_o = 1.5(93.94) = 140.91$ N/mm^2 $(fs) = \frac{S_{ut}}{\sigma_{max}} = \frac{200}{140.91} = 1.42$	3 2	8

Part B

(1Q x 10M = 10Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
5	Solution Given $P = \pm 1000$ N $S_{ut} = 540$ N/mm^2 $q = 0.85$ $R = 90\%$ $N = 10\,000$ cycles *Construction of S–N diagram* $S_e' = 0.5\,S_{ut} = 0.5(540) = 270$ N/mm^2 From Fig. 5.3 (hot drawn steel and $S_{ut} = 540$ N/mm^2), *Surface Factor*, $A = 0.53$ Assuming, $10 < d < 50$ mm, $B = 0.9$ For 90% reliability, $C = 0.897$ D/d = 1.5 and r/d = 0.25 From Fig. 4.25, $K_t = 1.5$ $K_f = 1 + q\,(K_t - 1) = 1 + 0.85\,(1.5 - 1) = 1.425$ $D = 1/K_f = 0.701$ Load bending E=1 $S_e = ABCDE\,S_e' = 0.53\text{x}0.9\text{x}0.897\text{x}0.701\text{x}1\text{x}270 = 80.98$ N/mm^2 $0.9S_{ut} = 0.9\,(540) = 486$ N/mm^2 $\log_{10}(0.9S_{ut}) = \log_{10}(486) = 2.6866$ $\log_{10}(S_e) = \log_{10}(80.98) = 1.90$	1 1 1 1 1	12

	The S–N curve for this problem is shown in below  	1 2 2	

Part C (1Q x 10M = 10Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
6	**Given** $P = 1$ kN $S_{ut} = 380$ N/mm^2 $(fs) = 2$ ***Step I*** *Calculation of permissible shear stress* According to maximum shear stress theory, $S_{sy} = 0.5\, S_{ut} = 0.5\,(380) = 190$ N/mm^2 The permissible shear stress is given by,	2	12

$$\tau_{max} = \frac{S_{yt}}{(fs)} = \frac{190}{2} = 95 \text{ N mm}^{-2} \quad \text{(i)}$$

1

Step II *Calculation of bending and torsional shear stresses*

$M = P \times (250) = (1000) \times (250) = 250 \times 10^3$ N mm

$M = P \times (500) = (1000) \times (500) = 500 \times 10^3$ N mm

$$\sigma_{xx} = \frac{M_A y}{I} = \frac{(250 \times 10^3)(d/2)}{(\pi d^4/64)}$$

$$= \left\{\frac{2546.48 \times 10^3}{d^3}\right\} \text{N mm}^{-2}$$

$$\tau = \frac{M_T r}{J} = \frac{(500 \times 10^3)(d/2)}{(\pi d^4/32)}$$

2

$$= \left\{\frac{2546.48 \times 10^3}{d^3}\right\} \text{N mm}^{-2}$$

Step III *Calculation of maximum shear stress*

The stresses at point *A* and corresponding Mohr's circle are shown in Fig. 4.40(b) and (c) respectively. In these figures,

$$\sigma_1 = \sigma_{xx} = \left\{\frac{2546.48 \times 10^3}{d^3}\right\} \text{N mm}^{-2} \qquad \sigma_2 = 0$$

$$\tau = \tau_{xy} = \tau_{yx} = \left\{\frac{2546.48 \times 10^3}{d^3}\right\} \text{N mm}^{-2}$$

From Mohr's circle,

$$\tau_{max} = \sqrt{\left(\frac{\sigma_1}{2}\right)^2 + (\tau_{xy})^2}$$

$$= \left[\sqrt{\left\{\frac{2546.48}{2d^3}\right\}^2 + \left\{\frac{2546.48}{d^3}\right\}^2}\right] \times 10^3$$

2

$$\frac{2847.05 \times 10^3}{d^3} \quad \text{(ii)}$$

Step IV *Calculation of shaft diameter*

Equating (i) and (ii),

$$\frac{2847.05 \times 10^3}{d^3} = 95 \qquad \therefore d = 31.06 \text{ mm}$$

2

1

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PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST - 2

Sem & AY: Odd Sem 2019-20 | **Date**: 18.11.2019

Course Code: MEC 210 | **Time**: 11.00 AM to 12.15 PM

Course Name: DESIGN OF MACHINE ELEMENTS-I | **Max Marks**: 40

Program & Sem: B.Tech (MEC) & V | **Weightage**: 20%

Instructions:

(i) ***Answer all questions from Part A, B and C***

(ii) ***Only scientific calculators are permitted***

(iii) ***Use of data hand book (by Dr K. Lingaiah) is allowed***

Part A [Memory Recall Questions]

Answer all the Questions. **(3Q=15M)**

1. Derive Soderbergs equation for fatigue loading.
   [4M] (C.O.NO.1) [Knowledge]
2. Discuss various types of welded joints and types of welding.
   [4M] (C.O.NO.1) [Knowledge]
3. Select a rectangular parallel key to be mounted on the shaft of diameter 50 mm transmitting 80 kW power at a rated speed of 750 rpm. Select C 40 steel as the material for the key with a factor of safety of 2.5.
   [7M](C.O.NO.3) [Comprehension]

Part B [Thought Provoking Questions]

Answer the Question. The Question carry fifteen marks. **(1Qx15M=15M)**

4. Fig.1 shows a transmission shaft carrying two pulleys B and C supported on bearings A and D. Power is supplied to the shaft by means of a vertical belt on pulley B and power is taken off from pulley C with horizontal belting. The maximum tension in the belt on the pulley B is 2.5 kN. The angle of contact for both the pulleys are 180^{o} and the coeff. of friction is 0.24. Considering a yield strength of 400 N/mm^2 for the shaft material and a factor of safety of 3, determine the shaft diameter based on maximum shear stress theory basis. Assume that the shaft is applied with sudden loads with minor shocks.

   (C.O.NO.4) [Application]

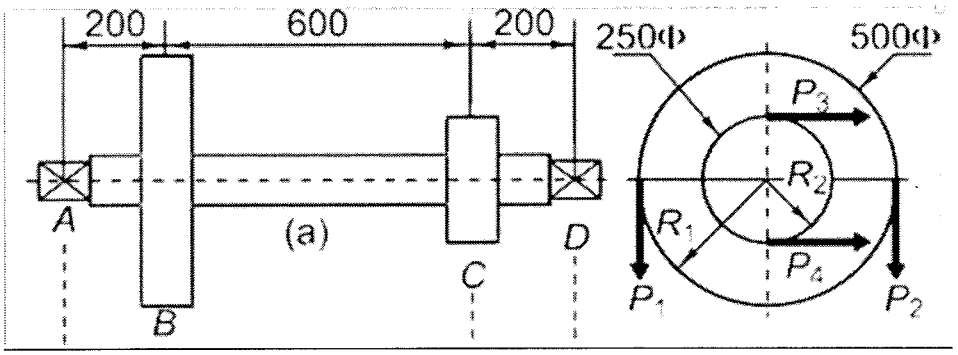

Fig. 1

Part C [Problem Solving Questions]

Answer the Question. The Question carry ten marks. **(1Qx10M=10M)**

5. A stepped plate as shown in Fig. 2 is made of carbon steel having ultimate tensile strength of 630 N/mm^2 is subjected to a fluctuating axial load of 50 kN. Considering size factor of 0.85, surface factor of 0.76 and load factor of 0.89 and factor of safety of 2, determine the thickness of the plate for a notch sensitivity factor of 0.8.

(C.O.NO.4) [Application]

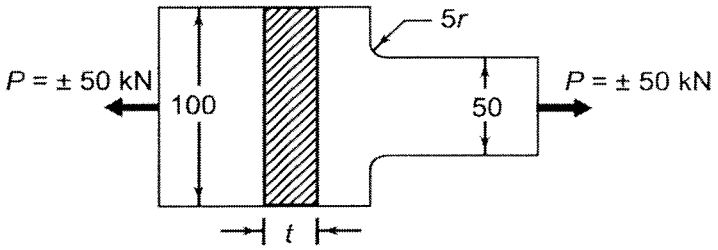

Fig. 2

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: V
Course Code: MEC 210
Course Name: DME-I

Date: Nov 2019
Time: 1 hour 15 min
Max Marks: 40
Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
Part-A	1,2,3,4	Module-2	K and C			15
Part-B	a or b	Module-3			A	15
Part-C	a or b	Module-4			A	10
	Total Marks					40

CO → ~~can~~ not clear

Annexure- II: Format of Answer Scheme

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SOLUTION

Semester: V
Course Code: MEC 210
Course Name: DME-1

Date: Nov 2019
Time: 1 hour 15 min.
Max Marks: 40
Weightage: 20%

Part A

Q No	Solution	Scheme of Marking	Max. Time required for each Question
Part-A	**Enclosed**	**4+4+7 = 15 marks**	**20 min**

Part B

(Q x M = Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
Part-B	**Enclosed**	**7+5+3 = 15**	**35 min**

Part C

(Q x M = Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
Part-C	**Enclosed**	**7+3 = 10**	**20 min**

Test-2 Solution Sheet (Design of Machine Elements MEC 210)

Dr. K. Gopinath Data Hand Book Eqtns to be used

Part-A

1) To derive Soderberg's equation

$$\frac{\sigma_a}{\sigma_{-1d}} + \frac{\sigma_m}{\sigma_{yd}} = 1 \quad \text{---- (5.40)} \quad \text{---- (4)}$$

(fig. of safe and failure line to be used)

2) Types of Joints (Lap & butt) ---- (2)
types of welding (parallel, transverse and combined) ---- (2)

3) length of Key based on shear ---- (3)
$l = 38.75$ mm

length of the Key based on crushing ---- (3)
$l = 62$ mm

Standardization from table (17-2)
$\boxed{l = 63}$ mm ---- (1)

Part-B

$(P_1 + P_2) = (2500 + 1176.47) = 3676.47$ N.

$(P_3 + P_4) = (5000 + 2352.9\text{N}) = 7352.94$ N

Finding all reactions — horizontal & vertical

Find $M_{bB} = 657664.26$ N-mm ---- (5)

table (14-2) for given condition

$K_b = 1.75$ and $K_t = 1.25$.

using Eqn (14-12) to find $D_1 = 54.47$ mm (3)

$\boxed{D = 56}$ mm

Part-C

Should use $F_a = \frac{F_{max} - F_{min}}{2}$ ___ (5.32)

$F_m = \frac{F_{my} + F_{mn}}{2}$ ___ (5.33) (7)

then (5.34a) and (5.34b)

- finally use Modified Soderberg's Eqns →

Modify Eqn (5-40) considering K_{sr}, K_{s2} and K_t with K_{T-1} — to find t. (3)

$\boxed{t = 10}$ mm

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BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019-20
Course Code: MEC 210
Course Name: DESIGN OF MACHINE ELEMENTS -1
Program & Sem: B.Tech (MEC) & V

Date: 24 December 2019
Time: 9:30 AM to 12:30 PM
Max Marks: 80
Weightage: 40%

Instructions:
(i) Use of Design Data Hand book by Dr. K. Lingaiah is permitted
(ii) Answer all questions from Part A, B and C

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 2 marks. **(5Qx2M=10M)**

1. Define design code and design specification. (C.O.No.1)[Knowledge]
2. Define endurance limit and endurance limit stress. (C.O.No.2)[Knowledge]
3. Define strass concentration and stress concentration factor. (C.O.No.2)[Knowledge]
4. Explain size and surface finish factors w.r.t. fatigue loading. (C.O.No.2)[Knowledge]
5. Define self locking and overhauling screws with the condition. (C.O.No.1)[Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. **(3Q=35M)**

6. Determine the diameter of the round rod 'd' which is 200 mm long to sustain a load of 5 kN that falls axially from a height of 25 mm. Select C20 as the material (σ_y = 117.68 Mpa) for the rod with a factor of safety of 2.5 .

[7M] (C.O.No.2) [Application]

7. A stepped shaft with a reduction ratio of 1.2 is to have a fillet radius 10% of the smaller diameter. The shaft is to be made of material that has a notch sensitivity factor of 0.925, shear stress of 160 Mpa at yield and shear stress of 120 Mpa in endurance limit. The component has a surface factor of 0.95, load factor of 1 and size factor of 0.85. Determine the diameter of the stepped shaft to sustain a twisting moment that fluctuates between +800 N-m and – 500 N-m considering a factor of safety of 2.5. Also give the final specifications of the stepped shaft.

[15M] (C.O.No.3) [Application]

8. Design the following for a longitudinal riveted joint (refer design data hand book: considering type-r, butt joint) according to Indian Boiler Regulations (IBR) for 1.8 m diameter boiler subjected to an internal pressure of 0.9 n/mm^2. The allowable tensile strength of the plate material is 105 N/mm^2 and allowable stress for the rivet material are 60 N/mm^2 in shear and 150 N/mm^2 in crushing.
   a) Diameter of the rivet
   b) Pitch and transverse pitch for placing rivets
   c) Efficiency based on strength of plates. [13M] (C.O.No.4) [Application]

Part C [Problem Solving Questions]

Answer both the Questions. **(2Q=35M)**

9. Design the following parts of the screw jack for a lift of 300 mm to rise a load of 50 kN. Select C40 steel as the material for screw and handle bar (σ_y = 328.6 Mpa), Young's modulus of elasticity E= 206.8 Gpa and soft phosphor bronze for the nut (allowable bearing pr. $\sigma_b{}^l$ = 14 Mpa). Take factor of safety of 3 and coefficient of friction for all friction surfaces as 0.14. (no need to check for stresses)
   a) Screw and check for buckling using Johnsons Parabolic formula (refer design data hand book for the formula)
   b) Nut for the screw jack
   c) Handle bar (tommy bar) [20M] (C.O.No.5) [Application]

10. Design the following parts of a rigid flange coupling to transmit 60 kW power at a rated speed of 500 rpm.
   a) Shaft b) Key (based on shear) c) Bolt (bolt dia, bolt circle dia and no. of bolts)

   For the shaft and the key take σ_{yd} = 131.64 Mpa and τ_{yd} = 65.72 Mpa (no need to check for stresses)

   [15M] (C.O.No.3) [Application]

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

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END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1			**K**			10
2			**C**			07
3			**A**			15
4			**A**			13
5			**A**			20
6			**A**			15
	Total Marks					**80**

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Commend:

Format of Answer Scheme

SCHOOL OF ENGINEERING

SOLUTION

Semester:5
Course Code: MEC 210
Course Name: Design of Machine Elements -1
Program & Sem: Mech Engg 5th sem

Date: Dec 2019
Time: 3 HRS
Max Marks: 80
Weightage: 40%

Part A (5Q x 2M = 10 Marks)

Q No	Solution	Scheme of Marking	
1	**Enclosed**	**Enclosed**	**30 min**

Part B (35 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	**Enclosed**	**Enclosed**	**15 min**
2	**Enclosed**	**Enclosed**	**30 min**
3	**Enclosed**	**Enclosed**	**30 min**

Part C (35 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	**Enclosed**	**Enclosed**	**45 min**
2	**Enclosed**	**Enclosed**	**30 min**

Solution Sheet (MEC 210) 5th Mech

Part-A

-Self explanatory-

Part-B

1) $\sigma_{yd} = 117.68$ $E = 206.8\ GPa$

use eqn (3.11c) from data hand book

$d = 154.78$ $\boxed{d = 150}$ mm

---

2) Find τ_{max} τ_{min} $\tau_{mean} = \dfrac{763.95 \times 10^3}{d^3}$

$\tau_{amp} = \dfrac{3310.45 \times 10^3}{d^3}$

ref fig (4.17) $K_\sigma = 1.34$

$\therefore K_{\sigma-1} = 1.3145$.

using modified Soderberg's equation for torsion. $d = 49.895$

$\boxed{d = 50\ mm}$

Specifications $D = 60\ mm$ $d = 50\ mm$ $r = 5\ mm$

---

3) thickness of the plate $h = 11$ mm

use Eq (13.5c) $\boxed{d = 20}$ mm

use eqn. (13.30) for pitch 'p'

$p = 106.46$ mm

from table (13-14) for type-V

$p = 30.93$ (select least)

say $\boxed{p = 30}$ mm

$p_t = 2d = 40$ mm

Strength of solid plate (13-20) $F_0 = 105105$ N

Strength of perforated plate (13-21) $F_0 = 80850$ N

$\therefore \eta_{plate} = 76.92\%$

Part-G

1) take 25% over load Core area $A_c = 570.62$ mm^2

standardize from table (18.8) $A_c = 707$ mm^2

for which $\boxed{d = 36 \quad d_1 = 30 \quad p = 6 \text{ mm}}$

use Johnson parabolic formula. $F_{cr} = 157.25$ kN (safe design)

use Eqn (18.40) no. of threads $i = 12$.

$\therefore$ length of nut = $\boxed{72 \text{ mm}}$.

tacking $M_t = M_b$ dia of handle = 32 mm

and length of handle = 1180 mm

2) use Eqn (19.2) shaft $\boxed{d = 50}$ mm ($\eta = 80\%$)

table (17-11) select key $b = 14$ & $h = 9$ mm

longest in linear is 49.82 $\boxed{l = 50 \text{ mm}}$

use Eqn (19.16) and (19.18)

$\therefore$ dia of bolt $d_1 = 12.5$ mm BCD = 150 mm

nearest is (M16 × 2)