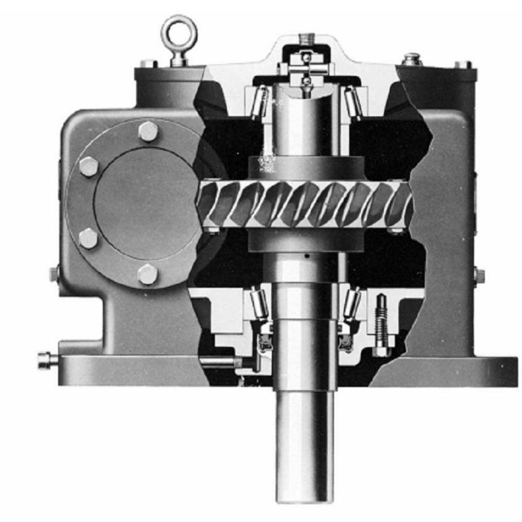
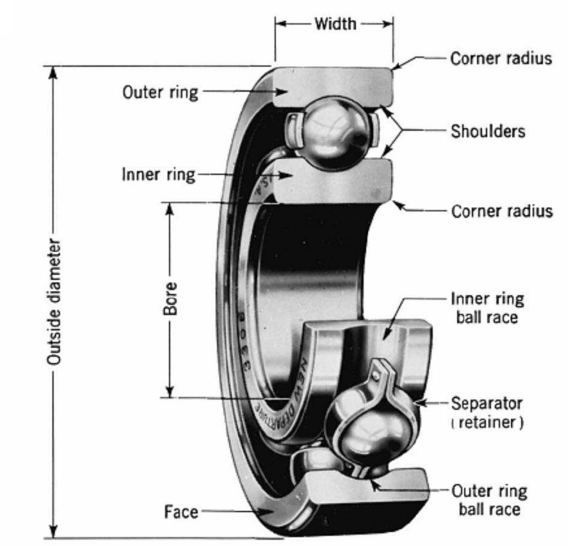
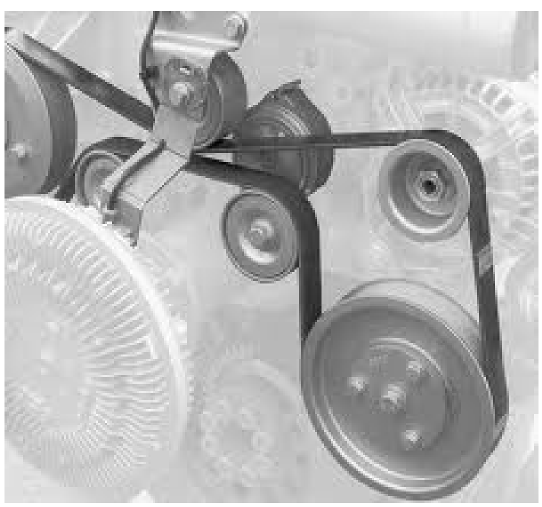
Tribhuvan University
Institute of Engineering

Mechanical Department





Machine Design I: Practical book



Author: Dr. Sanjeev Maharjan

Laboratory 1: Chosen to relate t course material; the design process, decision making and new product design.

Roll no	Topics	Roll no	Topics
601	Design process: introduction	625	3.5 planning for manufacturer
602	1.2 basic steps in the design and synthesis process	626	3.6 planning for distribution and use
603	1.2.1 recognition of need	627	3.7 planning for retirement
604	1.2.2 definition of the problem	628	4. problem solving
605		629	4. decision making
606	1.2.3 gathering relevant information, functional requirements	630	4.1 the problem solving process
607	1.2.4 conceptualization	631	4.2 creative problem solving
608	1.2.5 evaluating alternatives	632	4.3 invention
609	1.2.6 communication	633	4.4 brainstorming
610	1.2.7 feedback from manufacturer and user	634	4.5 problem statement
611	1.3 communicating the design	635	4.6 needs
612	1.3.1 drawings and CAD	636	4.6 goals
613	1.3.2 Charts and graphs	637	4.6 constraints
614	2 Materials selection	638	4.6 compromises
615	2.1 Information on materials properties	639	4.6 conditions
616	2.2 economics of materials	640	4.6 criteria for evaluation
617	2.3 evaluation methods for materials selection	641	4.7 problem solving: preparation
618	2.4 cost versus performance relations	642	4.8 Problem solving: incubation
619	2.5 cost and value analysis	643	4.9 Problem solving: inspiration
620	3.1 new product design	644	4.10 Problem solving: verification
621	3.2 feasibility studies	645	4.11 Decision matrix
622	3.3 preliminary design	646	4.12 Decision Tree
623	3.4 detailed design and analysis	647	4.13 Relevant problems:: problem solving and decision making
624	Compile manuscripts prepared by group A.	648	Compile manuscripts prepared by group B.

Note:
**** Students are required to refer mechanical engineering design textbook, research article and other resources thoroughly.**
**** Content should not be less that half page and not more that 1 page (A4 size photo copy paper) including images, diagrams, and block diagram etc.**

Laboratory 2: Review of research article and PPT presentation. In this laboratory work, students will be provided journal articles regarding gearbox vibration, gear meshing, linkage mechanism, robotics, pressure vessels, structural integrity and others. After reviewing journal articles, students should prepare PPT slides and present the learning based on the journal articles.

Laboratory 3: Prepare Bearing manuscript: find the bearing retailer or dealer shop in Kathmandu Valley. From that shop select a bearing of your interest. Then write an article on the selected bearing. An article should content followings:

a) **Introduction of selected bearing**
b) **Figure of bearing**
c) **Data catalogue**
d) **Selection of that bearing based on radial or axial load**
e) **Appication of bearing and**
f) **Others.**

ball bearing
6203 2RS

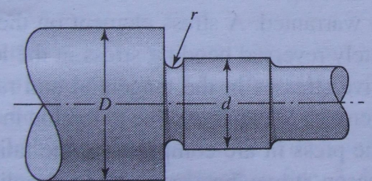
Laboratory 4: Design of shaft: In this practical work, students will be given a series of design questions regarding shaft design. The objective of the practical work is to develop capacity to solve shaft design analytically. Some sample design works are given below for reference:

7–1 A shaft is loaded in bending and torsion such that $M_a = 70$ N · m, $T_a = 45$ N · m, $M_m = 55$ N · m, and $T_m = 35$ N · m. For the shaft, $S_u = 700$ MPa and $S_y = 560$ MPa, and a fully corrected endurance limit of $S_e = 210$ MPa is assumed. Let $K_f = 2.2$ and $K_{fs} = 1.8$. With a design factor of 2.0 determine the minimum acceptable diameter of the shaft using the

(*a*) DE-Gerber criterion.
(*b*) DE-elliptic criterion.
(*c*) DE-Soderberg criterion.
(*d*) DE-Goodman criterion.

Discuss and compare the results.

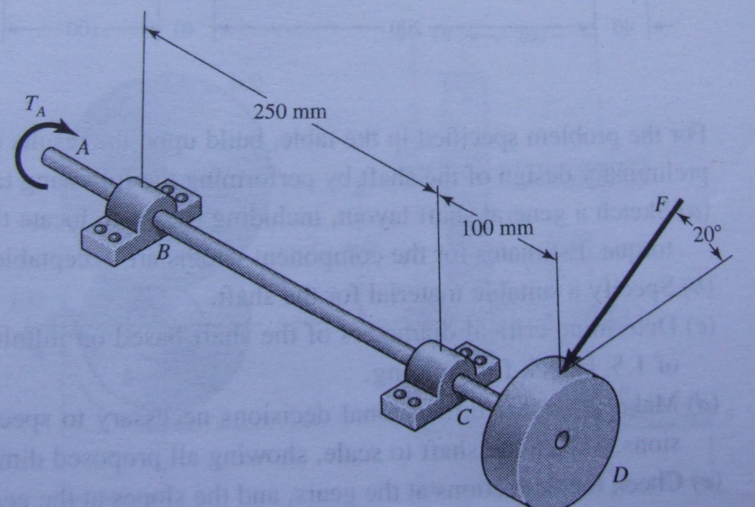
7–2 The section of shaft shown in the figure is to be designed to approximate relative sizes of $d = 0.75D$ and $r = D/20$ with diameter d conforming to that of standard metric rolling-bearing bore sizes. The shaft is to be made of SAE 2340 steel, heat-treated to obtain minimum strengths in the shoulder area of 1226 MPa ultimate tensile strength and 1130 MPa yield strength with a Brinell hardness not less than 370. At the shoulder the shaft is subjected to a completely reversed bending moment of 70 N · m, accompanied by a steady torsion of 45 N · m. Use a design factor of 2.5 and size the shaft for an infinite life.



Problem 7–2

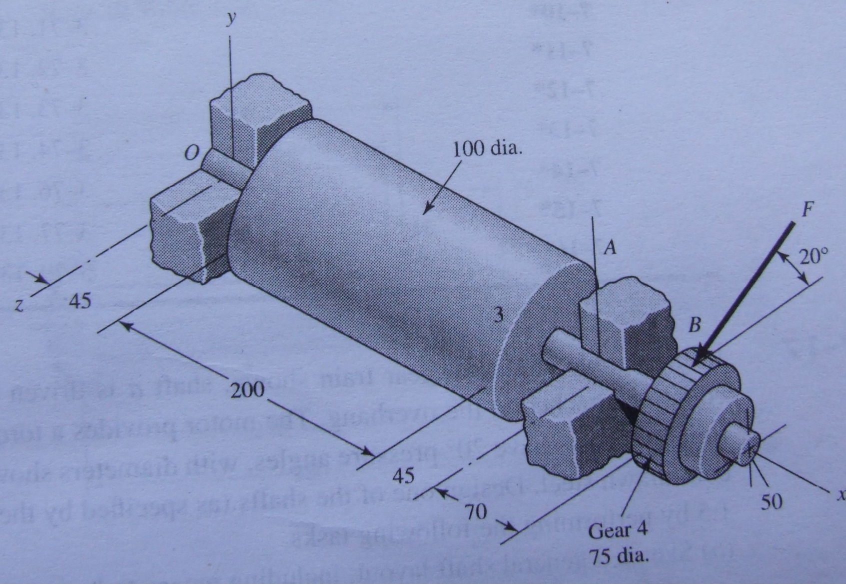
Section of a shaft containing a grinding-relief groove. Unless otherwise specified, the diameter at the root of the groove $d_r = d - 2r$, and though the section of diameter d is ground, the root of the groove is still a machined surface.

7–3 The rotating solid steel shaft is simply supported by bearings at points B and C and is driven by a gear (not shown) which meshes with the spur gear at D, which has a 150-mm pitch diameter. The force F from the drive gear acts at a pressure angle of 20°. The shaft transmits a torque to point A of $T_A = 340$ N · m. The shaft is machined from steel with $S_y = 420$ MPa and $S_{ut} = 560$ MPa. Using a factor of safety of 2.5, determine the minimum allowable diameter of the 250-mm section of the shaft based on (*a*) a static yield analysis using the distortion energy theory and (*b*) a fatigue-failure analysis. Assume sharp fillet radii at the bearing shoulders for estimating stress-concentration factors.



Problem 7–3

7–4 A geared industrial roll shown in the figure is driven at 300 rev/min by a force F acting on a 75-mm diameter pitch circle as shown. The roll exerts a normal force of 5200 N/m of roll length on the material being pulled through. The material passes under the roll. The coefficient of friction is 0.40. Develop the moment and shear diagrams for the shaft modeling the roll force as (a) a concentrated force at the center of the roll, and (b) a uniformly distributed force along the roll. These diagrams will appear on two orthogonal planes.



roblem 7–4
nder the roll.
millimeters.

7–5 Design a shaft for the situation of the industrial roll of Prob. 7–4 with a design factor of 2 and a reliability goal of 0.999 against fatigue failure. Plan for a ball bearing on the left and a cylindrical roller on the right. For deformation use a factor of safety of 2.

Laboratory 5: Power transmission of sheet bender at mechanical workshop. In this exercise, students will observe the sheet bender located at mechanical workshop. After observation, students will collect the necessary data for the analysis of the given sheet bender, such as

a) types of gear used
b) Numbers of tooth of gears, radius of gears, module, pitch circle, pressure angle etc..
c) gears and shaft alignment
d) length, diameter of shafts
e) types of bearings used
f) bearing loads or reaction forces at bearing housing.
g) Driving force at the lever
h) Revolution of driving arm
i) And other necessary measurements

Based on the above collected information , students should verify the shaft diameter, find the bearing forces or reaction forces, gear train and transmitted load at gear meshing.

Figure: Sheet bender at mechanical workshop