INSTITUTE OF AERONAUTICAL ENGINEERING
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Lab Manual:

Aerospace Structural Dynamics Laboratory(AAEC45)

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Contents

INTRODUCTION

1.1 Introduction

This course is intended to enhance the learning experience of the student in topics encountered in Engineering Physics Course AHSC03.In this lab, students are expected to develop the practical skills required to do the experiments and gain experience in using the basic measuring devices used in Computer Science Engineering. Students also learn to interpret the experimental results in terms of the concepts introduced in the Engineering Physics course.How the student performs in the lab depends on his/her preparation and participation. Each student must participate in all aspectsof the lab to ensure a thorough understanding of the equipment and concepts. The student, Faculty teachingthe lab course, Laboratory In-charge and faculty coordinator all have certain responsibilities towards successful completion of the lab's goals and objectives.

1.1.1 Student Responsibilities

The student is expected tocome prepared for each lab.Lab preparation includes understanding the labexperiment from the lab manual and reading the related textbook material.

Students have to write the allotted experiment for that particular week in the work sheets given and carry them to the Lab. In case of any questions or problems with the preparation, students can contact the Faculty Teaching the Lab course, but in a timely manner.

Students have to be in formal dress code, wear shoes and lab coat for the Laboratory Class.

After the demonstration of experiment by the faculty, student has to perform the experiment individually. They have to note down the observations in the observation Tables drawn in work sheets, do the calculations and analyze the results.

Active participation by each student in lab activities is expected. The student is expected to ask the Faculty any questions they may have related to the experiment.

The student should remain alert and use commonsense while performing the lab experiment.They are also responsible for keeping a professional and accurate record of the labexperiments in the files provided.

1.1.2 Responsibilities of Faculty Teaching the Lab Course

The Faculty shall be completely familiar with each labprior to the laboratory. He/She shall provide the students with details regarding the syllabus and safety review during the first week.Lab experiments should be checked in advance to make sure that everything is in working order.The Faculty should demonstrate and explain the experiment and answer any questions posed by the students.Faculty have to supervise the students while they perform the lab experiments. The Faculty is expected to evaluate the lab worksheets and grade them based on their practical skills and understanding of the experiment by taking Viva Voce. Evaluation of work sheets has to be done in a fair and timely manner to enable the students, for uploading them online through their CMS login within the stipulated time.

1.1.3 Laboratory In-charge Responsibilities

The Laboratory In-charge should ensure that the laboratory is properly equipped, i.e., the Faculty teaching the lab receive any equipment/components necessary to perform the experiments.He/She is responsible for ensuring that all the necessary equipment for the lab is available and in working condition. The Laboratory In-charge is responsible for resolving any problems that are identified by the teaching Faculty or the students.

1.1.4 Course Coordinator Responsibilities

The course coordinator is responsible fo rmaking any necessary corrections in Course Description and lab manual. He/She has to ensure that it is continually updated and available to the students in the CMS learning Portal.

1.2 Lab Policy and Grading

The student should understand the following policy:

ATTENDANCE: Attendance is mandatory as per the academic regulations.

LAB RECORD's: The student must:

1. Write the work sheets for the allotted experiment and keep them ready before the beginning of eachlab.
2. Keep all work in preparation of and obtained during lab.
3. Perform the experiment and record the observations in the worksheets.
4. Analyze the resultsand get the work sheets evaluated by the Faculty.
5. Upload the evaluated reports online from CMS LOGIN within the stipulated time.

Grading Policy:

The final grade of this course is awarded using the criterion detailed in the academic regulations. A large portion of the student's grade is determined in the comprehensive final exam of the Laboratory course (SEE PRACTICALS),resulting in a requirement of understanding the concepts and procedure of each lab experiment for successful completion of the lab course.

Pre-Requistes and Co-Requisties:

The lab course is to be taken during the samesemester as AHSC03, but receives a separate grade. Students are required to have completed both AHSC03 and AHSC05 with minimum passing grade or better grade in each.

1.3 Course Goals and Objectives

The Physics Laboratory course is designed as a foundation course to provide the student with the knowledge to understand the basic concepts in Physics which have lot of applications in the field of Engineering.

The experiments are designed to complement the concepts introduced in AHSC03. In addition, the student should learn how to record experimental results effectively and present these results in a written report.

More explicitly, the class objectives are:

1. To gain proficiency in the use of common measuring instruments.

2. To enhance understanding of theoretical concepts including:

   - Carrier concentration in semiconducting materials
   - Waves in one Dimension
   - Magnetic Induction
   - Hysteresis losses.
   - Energy Gap in a semiconductor.
   - Photo Diode and its working Principle
   - Numerical Aperture and Acceptance angle of an Optical Fiber.
   - Diffraction due to N Slits
   - Planck's constant
   - Light Emitting Diode and its Working Principle
   - Interference in thin Films
   - Diffraction due to Single slit

3. To develop communication skills through:

   - Verbal interchanges with the Faculty and other students.
   - Preparation of succinct but complete laboratory reports.
   - Maintenance of laboratory worksheets aspermanent, written descriptions of procedures, analysis and results.

4. To compare theoretical predictions with experimental results and to determine the source of any apparent errors.

1.4 Use of Laboratory Instruments

One of the major goals of this lab is to familiarize the student with the proper equipment andtechniques for conducting experiments. Some understanding of the lab instruments is necessaryto avoid personal or equipment damage.By understanding the device's purpose and following a fewsimple rules, costly mistakes can be avoided.

The following rules provide a guideline for instrument protection.

1.4.1 Instrument Protection Rules

1. New students must receive an orientation on lab operating procedures before working in a lab.

2. Students shall publish a safety checklist for equipment for which they are responsible.

3. Students must read the safety checklist for each piece of equipment before operating it.

4. Ensure you know the location of the emergency stop button before starting equipment.

5. Always depressurize accumulators or pneumatic reservoirs before working on fluid power apparatus.

6. Check the application pressure, system pressure, and component pressure before connecting a system to a pump or pressure source. The maximum operating pressures are listed on equipment labels or published on manufacturer websites.

7. Periodically check hoses for leakage, cracks, kinks, or breaks.

8. Test your equipment for leaks at low pressure before raising the pressure to the operating pressure.

9. All components shall operate within manufacturer's specifications.

10. Equipment shall incorporate an emergency stop or emergency return control, whichever provides maximum safety.

11. Emergency stops shall be readily accessible under all conditions of working and shall operate immediately.

12. Equipment shall be designed so that loss of electrical, pneumatic and/or hydraulic power shall not cause a hazard.

13. Pump inlet temperatures should not exceed 600C when maximum ambient temperatures exist.

14. Rotating parts shall be guarded to provide adequate protection against hazard.

15. Flexible hoses shall only be used where necessary. Their length shall be minimized and they shall be protected from abrasion. If failure causes a hazard, the hose shall be restrained or shielded.

1.5 Data Recording and Reports

1.5.1 The Laboratory Notebook:

Students must record their experimental values in the provided tables in this laboratory manual and reproduce them in the lab reports. Reports are integral to recording the methodology and results of an experiment. In engineering practice, the laboratory notebook serves as an invaluable reference to the technique used in the lab and is essential when trying to duplicate a result or write a report. Therefore, it is important to learn to keep accurate data. Make plots of data and sketches when these are appropriate in the recording and analysis of observations. Note that the data collected will be an accurate and permanent record of the data obtained during the experiment and the analysis of the results. You will need this record when you are ready to prepare a lab report.

1.5.2 The Laboratory Worksheets:

Reports are the primary means of communicating your experience and conclusions to other professionals. In this course you will use the lab report to inform your LTA about what you did and what you have learned from the experience. Engineering results are meaningless unless they can be communicated to others. You will be directed by your LTA to prepare a lab report on a few selected lab experiments during the semester. Your assignment might be different from your lab partner's assignment.
Your laboratory report should be clear and concise. The lab report shall be typed on a word processor. As a guide, use the format on the next page. Use tables, diagrams, sketches, and plots, as necessary to show what you did, what was observed, and what conclusions you can draw

from this. Even though you will work with one or more lab partners, your report will be the result of your individual effort in order to provide you with practice in technical communication.

CONCLUSIONS - The conclusion section should provide a take-home message summing up what has been learned from the experiment:

1. Briefly restate the purpose of the experiment (the question it was seeking to answer)
2. Identify the main findings (answer to the research question)
3. Note the main limitations that are relevant to the interpretation of the results
4. Summarise what the experiment has contributed to your understanding of the problem.

LAB-1 GOVERNING

2.1 Introduction

In the first lab period, the students should become familiar with the location of equipment and components in the lab, the course requirements, and the teaching instructor. Students should also make sure that they have all of the co-requisites and pre-requisites for the course at this time.

2.2 Prelab Preparation:

Read Appendix B and Appendix C of this manual, paying particular attention to the reason for doing this lab. Prior to coming to lab class, need to follow the below objective and answer the preLab Questions.

2.3 Objective

To familiarize the students with the lab facilities, equipment, standard operating procedures, lab safety, and the course requirements.

2.4 Prelab Questions:

1. What is the function of a governor?
2. State the different types of governors.
3. What is the stability of a governor?
4. Define the Sensitiveness of governor.

2.5 In Lab Experiment

2.5.1 Equipment needed

1. Watt Governor Arrangement AMEB06 lab manual.(1 to 12 experiments list)

2.6 Procedure

1. During the first laboratory period, the instructor will provide the students with a general idea of what is expected from them in this course. Each student will receive a copy of the syllabus, stating the instructor's contact information. In addition, the instructor will review the safety concepts of the course.

2. During this period, the instructor will briefly review the equipment which will be used throughout the semester. The location of instruments, equipment, and components (e.g. resistors, capacitors, connecting wiring) will be indicated. The guidelines for instrument use will be reviewed.

3. The drive unit consists of a small electric motor. The optional governor mechanics can be mounted on spindle. Precise speed control is afforded by the dimmer-stat. A counter bolt is provided to measure the speed with tachometer (not in our scope of supply). A graduated scale is fixed to the bracket and guided in vertical direction.

4. The center sleeve of the Porter and Proell governor incorporates a weight sleeve to which weights can be added. The Hratnell governor provides means of varying spring rate and initial compression level and mass of rotating weight. This enables the Hartnell Governor to be operated as a stable or unstablegovernor.

5. The apparatus is designed to exhibit the characteristics of the spring-loaded governor and dead weight governor.

6. A D. C. Motor drives the apparatus. The DC Motor is mounted on a steel base. The apparatus can perform following experiments,
   1) Watt, 2) Porter, 3) Proell, 4) Hartnelltype.

2.7 EXPERIMENTAL PROCEDURE:

The control unit is switched on and the speed control slowly rotated, increasing the governor speed until the center sleeve rises off the lower stop and aligns with the first division on the graduated scale. The sleeve position and speed are then recorded. Speed may be determined using hand tachometer on the spindle. The governor speed is then increased in steps to give suitable sleeve movements, and readings repeated at each stage throughout the range of sleeve movement possible.
The result may be plotted as curves of speed against sleeve position. Further tests are carried out changing the value of one variable at a time to produce a family or curves.

2.8 OPERATING INSTRUCTIONS:

For obtaining the graphs as mentioned above following instructions may be followed.

1. Arrange the set up as a Watt/ Porter, Proell Governor. This can be done by removing the upper sleeves on the vertical spindle of the governor and using proper linkages provided shows infig.

2. Make proper connections of themotor.

3. Increase the motor speed slowly andgradually.

4. Note the speed by tachometer and sleeve displacement on the scaleprovided.

5. Plot the graph of speed v/s sleeve displacement for watt, Porter, Proellgovernor.

6. Plot the graph of speed v/s governor height for Wattgovernor.

7. Plot the governor characteristic after doing the necessarycalculations.

2.9 Observation Table:

Sr.no	Governor speed N	Angular velocity	Sleeve displacement (X)	Height(H)	COS α = H/L	Radiu

Following graphs may than be plotted to study governor characteristics

1. Force v / s radius ofrotation.
2. Speed v / s Sleevedisplacement.

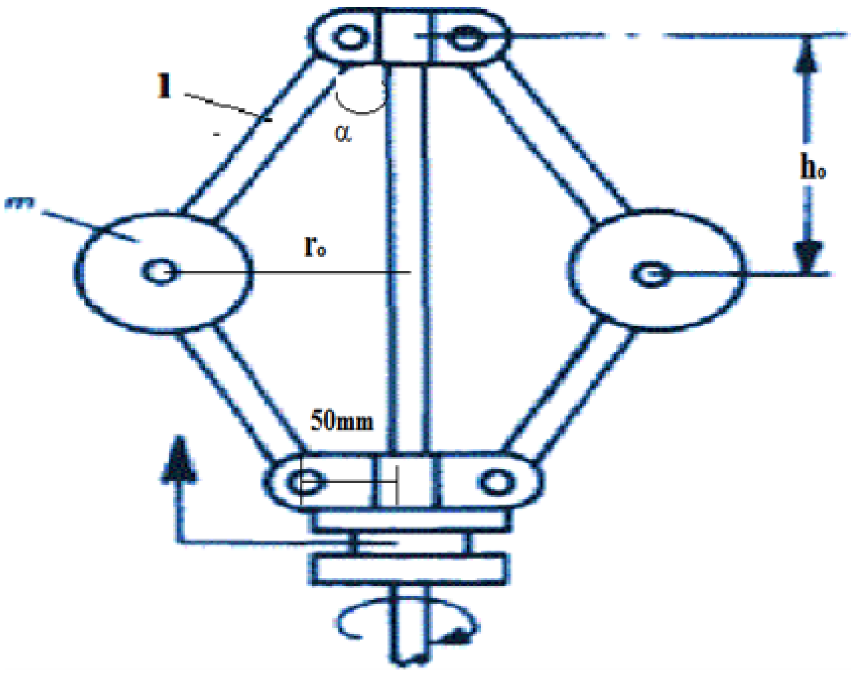


Figure 2.1: WATT GOVERNOR

2.10 Precautions:

1. Do not keep the mains “ON” when trial iscomplete.
2. Increase the speed gradually.
3. Take the sleeve displacement reading when the pointer remainssteady.
4. See that at higher speed the load on sleeve does not hit the upper sleeve of the governor.
5. While closing the test bring the dimmer to zero position and then switch “OFF” the motor.

2.11 Results:

2.12 PostLab Preperation:

2.12.1 Viva Questions:

1. What are the limitations of a Watt governor?
2. How does it differ from that of a flywheel?
3. Explain the term height of the governor.

2.12.2 Further Probing Experiments

1. Which of the governor is used to drive a gramophone?
2. What is the difference between centrifugal and inertia type governors?

LAB-2 Gyroscope

3.1 Introduction

AXIS OF SPIN:
If a body is revolving about an axis, the latter is known as axis of spin (Refer Fig.1, where OX is the axis ofspin).

PRECESSION:
Precession means the rotation about the third axis OZ (Refer Fig. 1) that is perpendicular to both the axis of spin OX and that of coupleOY.

AXIS OF PRECESSION: The third axis OZ is perpendicular to both the axis of spin OX and that of couple OY is known as axis of precession.

GYROSCOPIC EFFECT: To a body revolving (or spinning) about an axis say OX, (Refer Fig.1) if a couple represented by a vector OY perpendicular to OX is applied, then the body tries to process about an axis OZ which is perpendicular both to OX and OY. Thus, the couple is mutuallyperpendicular. The above combined effect is known as processional or gyroscopic effect.

3.2 Prelab Preparation

Study the working principle and construction of Gyroscope
Read Appendix B and Appendix C of this manual, paying particular attention to the reason for doing this lab. Prior to coming to lab class, need to follow the below objective and answer the preLab Questions.

3.3 Objective

To study the gyroscopic effect of a rotating disc.

3.4 Prelab Questions:

1. Write a short note on gyroscope.
2. What do you understand by gyroscopic couple?
3. Derive a formula for its magnitude.

3.5 In Lab Experiment

3.5.1 Equipment needed

1. Gyroscopictestrig.
2. Stop watch
3. Tachometer
4. **ElectricitySupply:** Single Phase, 220 V AC, 50 Hz 5-15 amp socket with earth connection, Bench Area Required: 1 m x 1m.

3.6 Theory;

Experimental justification of the equation $T = I.\omega.\omega P$. Couple by observation and measurement of results for independent variation in applied couple T and precession ω.

3.7 Procedure

1. Set the rotor at zeroposition.
2. Start the motor with the help of rotaryswitch.
3. Increase the speed of rotor with dimmer stat & stable it & measure the R.P.M. with the help oftachometer.
4. Put the weight on weight pan then yoke rotate atanticlockwise direction.
5. Measure the rotating angle (30o, 40o) with the help ofstopwatch.
6. Repeat the experiment for the various speeds andloads.
7. After the test is over set dimmer stat to zero position and switch off main supply.

3.8 Observation Table:

S. No.	N (RPM)	W (kg)	$d\theta$ (degree)	dt (sec)

3.9 Calculations:

$$T_{the} = I \omega \omega_p, \text{ kg-m} = \text{---------------}$$

$$I = \frac{W}{g} \times \frac{r^2}{2}, \text{ kg-m-sec2} = \text{---------------}$$

$$\omega = \frac{2 \times \pi \times N}{60}, \text{ rad/sec} = \text{---------------}$$

$$\omega_p = \frac{d\theta}{dt} \times \frac{\pi}{180}, \text{ rad/sec} = \text{---------------}$$

$$T_{act} = w L, \text{ kg m, kg-m} = \text{---------------}$$

3.10 Results:

3.11 PostLab Preperation

3.11.1 Viva Questions:

1. How do we calculate gyroscopic couple?
2. What are the applications of gyroscopic?
3. Explain the application of gyroscopic principles to air crafts.

3.11.2 Furthur Probing Experiments

1. What is the difference between theoretical gyroscopic couple and actual gyroscopic couple?
2. Discuss the effect of gyroscopic couple on a two wheeled vehicle while taking a turn?

LAB-3 Static force Analysis

4.1 Introduction

CONDITIONS FOR STATIC BALANCING:

If a shaft carries a number of unbalanced masses such that the center of mass of the system lies on the axis of rotation, the system is said to staticallybalance.

BALANCING OF SEVERAL MASSES ROTATING IN DIFFERENTPLANES:

When several masses revolve in different planes, they may be transferred to a reference plane (written as RP), which may be defined as the plane passing through a point on the axis of rotation and perpendicular to it. The effect of transferring a revolving mass (in one plane) to a reference plane is to cause a force of magnitude equal to centrifugal force of the revolving mass to act in the reference plane, together with a couple of magnitude equal to the product of the force and the distance between the plane of rotation and the reference plane. In order to have a complete balance of the several revolving masses in different planes, the following conditions must be satisfied:
1. The forces in the reference plane must balance, i.e. the resultant force must bezero.
2. The couple about the reference plane must balance, i.e. the resultant couple must be zero.
Let us now consider four masses m1, m2, m3 and m4 revolving in planes 1, 2, 3 and 4 shown in fig. The relative angular positions of these masses are shown in the end view
Fig. The magnitude, angular position and position of the balancing mass m1in plane 1may be obtained as discussed below:
1. Take one of the planes, say 1as the reference plane (R.P.). The distance of all the other planes to the left of the reference plane may be regarded as negative, and those to the right aspositive.
2. Tabulate the data as in table. The planes are tabulated in the same order i.e. 1, 2, RP

4.2 Prelab Preparation:

Study about rotating balancing system
Read Appendix B and Appendix C of this manual, paying particular attention to the reason for doing this lab. Prior to coming to lab class, need to follow the below objective and answer the preLab Questions.

4.3 Objective

To balance the masses statically of a simple rotating mass system and to observe the effect of unbalance in a rotating mass system.

4.4 Prelab Questions:

1. Write the importance of balancing?
2. Differentiate: static and dynamic balancing.
3. Define tractive force.

4.5 In Lab Experiment

4.5.1 Equipment needed

- Rotating mass balancesystem.
- Weights.

4.6 Description:

The apparatus consists of a steel shaft mounted in ball bearings in a stiff rectangular main frame. A set of four blocks of different weights is provided and may be detached from the shaft. A disc carrying a circular protractor scale is fitted to one side of the rectangular frame. A scale is provided with the apparatus to adjust the longitudinal distance of the blocks on the shaft. The circular protractor scale is provided to determine the exact angular position of each adjustable block. The shaft is driven by electric motor mounted under the main frame, through a belt. For static balancing of weights the main frame is suspended to support frame by chains then rotate the shaft manually after fixing the blocks at their proper angles. It should be completely balanced. In this position, the mo for dynamic balancing of the rotating mass system, the main frame is suspended from the support frame by two short links such that the main frame and the supporting frame are in the same plane. Rotate the statically balanced weights with the help of motor. If they rotate smoothly and without vibrations, they are dynamically balanced or driving belt should be removed.

4.7 Procedure

1. Insert all the weights in sequence 1- 2- 3 - 4 from pulleyside.
2. Fix the pointer and pulley onshaft.
3. Fix the pointer on θ o ($\theta 2$) on the circular protractorscale.
4. Fix the weight no. 1 in horizontalposition.
5. Rotate the shaft after loosening previous position of pointer and fix it on$\theta 3$.
6. Fix the weight no. 2 in horizontal position.
7. Loose the pointer and rotate the shaft to fix pointer on$\theta 4$.
8. Fix the weight no. 3 in horizontal position.
9. Loose the pointer and rotate the shaft to fix pointer on$\theta 1$.
10. Fix the weight no.4 in horizontal position.
11. Now the weights are mounted in correctposition.

12. For static balancing, the system will remain steady in any angularposition.
13. Now put the belt on the pulleys of shaft and motor.
14. Supply the main power to the motor through dimmerstat.
15. Gradually increase the speed of the motor. If the system runs smoothly and without vibrations, it shows that the system is dynamically balanced.
16. Gradually reduce the speed to minimum and then switch off the main supply to stop thesystem.

4.8 observation:

S.no	Plane	Mass, m(gms)	Angle from reference line ()	Distance (L)mm

CALCULATIONTABLE:

Plane	Mass, m	Mass movement (m)	Couple (m)

4.9 NOMENCLATURE:

L = Distance between particular weight from weight 1, mm W = Mass of particular weight, kg
θ = Angle of particular weight from Reference Point, degree

4.10 Precautions:

- Never run the apparatus if power supply is less than 180 volts & above than230volts.
- Increase the motor speed gradually.
- Experimental set up should be tight properly before conductingexperiment.
- Before starting the rotary switch, dimmer stat should be at zeroposition.

4.11 Results

4.12 PostLab Preperation:

4.12.1 Viva Questions:

1. What are the effects of hammer blow and swaying couple?

2. Write the formula to calculate couple?
3. What is the condition for static balancing?

4.12.2 Furthur Probing Experiments

1. Can a single cylinder engine be fully balanced? Why?
2. Where do we use the static force balancing?

LAB-4 Dynamic force Analysis

5.1 Introduction

CONDITIONS FOR DYNAMICBALANCING:
If a shaft carries a number of unbalanced masses such that the center of mass of the system lies on the axis of rotation, the system is said to statically balance. The resultant couple due to all the inertia forces during rotation must bezero.
These two conditions together will give complete dynamic balancing. It is obvious that a dynamically – balanced system is also statically balanced, but the statically balanced system is not dynamically balanced.

5.2 Prelab Preparation

This experiment is to be fusion of two pieces of metal by an electric arc between the pieces being joined. So, the working of Arc welding machine and the components available for the machine and procedure of the manufacture. So how the welding is been done can be studied on course AMEB05 so before doing the experiment be prepared with the prelab preparation of welding joining.

5.3 Objective

To balance the masses Statically & Dynamically of a simple rotating mass system and to observe the effect of unbalance in a rotating mass system.

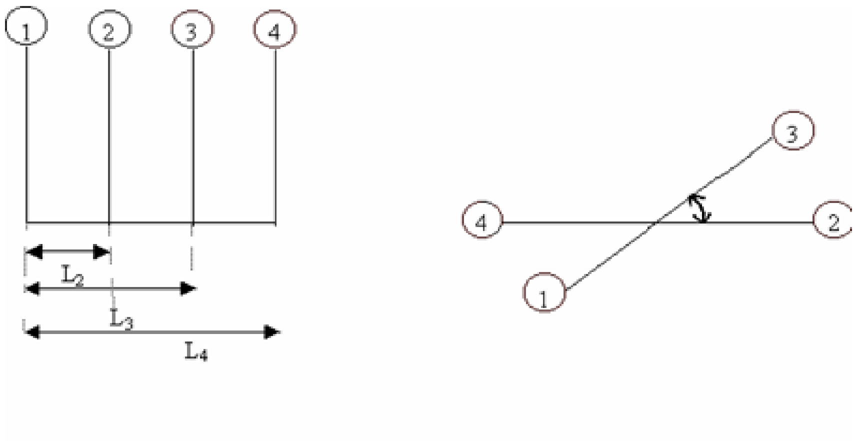
5.4 Prelab Questions:

1. Write the importance of balancing?
2. Differentiate: static and dynamic balancing?
3. What are the effects of hammer blow and swaying couple?

5.5 In Lab Experiment

5.5.1 Equipment needed

- Rotating mass balancesystem.
- Weights.



5.6 THEORY:

BALANCING OF SEVERAL MASSES ROTATING IN DIFFERENTPLANES:
When several masses revolve in different planes, they may be transferred to a reference plane (written as RP), which may be defined as the plane passing through a point on the axis of rotation and perpendicular to it. The effect of transferring a revolving mass (in one plane) to a reference plane is to cause a force of magnitude equal to centrifugal force of the revolving mass to act in the reference plane, together with a couple of magnitude equal to the product of the force and the distance between the plane of rotation and the reference plane. In order to have a complete balance of the several revolving masses in different planes, the following conditions must be satisfied:
‘

1. The forces in the reference plane must balance, i.e. the resultant force must bezero.

2. The couple about the reference plane must balance, i.e. the resultant couple must be zero.

Let us now consider four masses m1, m2, m3 and m4 revolving in planes 1, 2, 3 and 4 shown in fig. The relative angular positions of these masses are shown in the end view
Fig. The magnitude, angular position and position of the balancing mass m1in plane 1may be obtained as discussed below:

1. Take one of the planes, say 1as the reference plane (R.P.). The distance of all the other planes to the left of the reference plane may be regarded as negative, and those to the right aspositive.

2. Tabulate the data as in table. The planes are tabulated in the same order i.e. 1, 2,3.RP

5.7 DESCRIPTION:

The apparatus consists of a steel shaft mounted in ball bearings in a stiff rectangular main frame. A set of four blocks of different weights is provided and may be detached from the shaft. A disc carrying a circular protractor scale is fitted to one side of the rectangular frame. A scale is provided with the apparatus to adjust the longitudinal distance of the blocks on the shaft. The circular protractor scale is provided to determine the exact angular position of each adjustable block. The shaft is driven by electric motor mounted under the main frame, through a belt. For static balancing of weights the main frame is suspended to support frame by chains then rotate the shaft manually after fixing the blocks at their proper angles. It should be completely balanced. In this position, the mo for dynamic balancing of the rotating mass system, the main frame is suspended from the support frame by two short links such that themain frame and the supporting frame are in the same plane. Rotate the statically balanced weights with the help of motor. If they rotate smoothly and without vibrations, they are dynamically balanced or driving belt should be removed.

5.8 Procedure

1. Insert all the weights in sequence 1- 2- 3 - 4 from pulleyside.
2. Fix the pointer and pulley onshaft.
3. Fix the pointer on θ o (θ2) on the circular protractorscale.
4. Fix the weight no. 1 in horizontalposition.
5. Rotate the shaft after loosening previous position of pointer and fix it onθ3.
6. Fix the weight no. 2 in horizontalposition.
7. Loose the pointer and rotate the shaft to fix pointer onθ4.
8. Fix the weight no. 3 in horizontalposition.
9. Loose the pointer and rotate the shaft to fix pointer onθ1.
10. Fix the weight no.4 in horizontalposition.
11. Now the weights are mounted in correctposition.
12. For static balancing, the system will remain steady in any angularposition.
13. Now put the belt on the pulleys of shaft andmotor.
14. Supply the main power to the motor throughdimmerstat.
15. Gradually increase the speed of the motor. If the system runs smoothly and without vibrations, it shows that the system is dynamicallybalanced.
16. Gradually reduce the speed to minimum and then switch off the main
17. supply to stop the system.

5.9 observation:

S.no	Plane	Mass, m(gms)	Angle from reference line ()	Distance (L)mm

CALCULATIONTABLE:

Plane	Mass, m	Mass movement (m)	Couple (m)

5.10 NOMENCLATURE:

L = Distance between particular weight from weight 1, mm W = Mass of particular weight, kg
θ = Angle of particular weight from Reference Point, degree

5.11 Precautions:

- Never run the apparatus if power supply is less than 180 volts & above than230volts.
- Increase the motor speed gradually.
- Experimental set up should be tight properly before conductingexperiment.
- Before starting the rotary switch, dimmer stat should be at zeroposition.

5.12 Results

5.13 PostLab Preperation:

5.13.1 Viva Questions:

1. Write the formula to calculate mass movement?
2. Define tractive force.
3. What is the condition for dynamic balancing?

5.13.2 Furthur Probing Experiments

1. Can a single cylinder engine be fully balanced? Why?
2. Where do we use the dynamic force analysis?

LAB-5 Balancing

6.1 Introduction

Objective: To determine the Some field pressure function agrees with the experimental pressure curve within reasonable limits./ To study the pressure profile of lubricating conditions of load and speed.

6.2 Prelab Preparation

Read Appendix B and Appendix C of this manual, paying particular attention to the reason for doing this lab. Prior to coming to lab class, need to follow the below objective and answer the preLab Questions.

6.3 Objective

To Determine the Balancing Forces and Reciprocating Masses

6.4 Prelab Questions:

1. The journal bearings are generally used in.
2. The basic type of motion of a body is not the translation motion only.
3. Coplanar forces are not easily simplified in the simplification of the force and couple system in the calculations of forces in the journal bearings.

6.5 In Lab Experiment

6.5.1 Equipment needed

- Reciprocating Masses Test rig
- Balancing

6.6 Theory:

The Mathematical analysis of the behavior of journal in a bearing falls into two distinct categories as given in the appendix of this manual. They are,
1) Hydrodynamics of fluid flow between plates.
2) Journal bearing analysis where the motion of the journal in the oil film is considered.
According to equation the Somerfield pressure function (When the velocity of the eccentricity

and the whirl speed of the journal are both zero) is given by
Where P is the pressure of the oil film at the point measured clockwise from the line of common centers $(0\ddot{0})$ and $P = P_0$ at $\theta = 0$ and $\theta = \pi$ refer the fig.
Note: – Some books on lubrication give the Summerfield function with a negative sign for n. This is true if it is measured from the point of minimum thickness of the oil film that is

$$h = \delta(1 - nCos\theta)$$

It is also proved in the analysis that maximum pressure occurs at

$$Cos\theta_m = \frac{3m}{2 + n^2}$$

6.7 SPECIFICATIONS:

1. DiameterofJournal = (A) = 2R =55mm
2. Diameterofbearing = (E) = 2r = 70mm (With 16 radialtapings)
3. Bearingwidth = (L) =15mm
4. Weight of bearing withattachment= 1.7 kg
5. Weight ofbalancingload = (J)=
6. Set of weights isprovided.
7. MotorD. C. = 0.5 HP, 1500 rpm. Variable speed.
8. Dimmer state is provided for speed variation.
9. Manometer board with 16 tubes and suitable height with suitable scales and adjustable oil tank.
10. Recommendedoil = Lubricating oil SAE 20 or SAE30.
11. Supplyrequired = A. C., 1 HP, 230 V., 50 c/sec., stabilized.

6.8 Procedure

1. Fill the oil tank by using SAE 20 or SAE 30 lubricating oil under test and position the tank at the desiredheight.
2. Drain out the air from all the tubes on the manometer and check level balance with supply levelIndicator.
3. Check that some oil leakage is there. Some leakage of oil is necessary for cooling purpose.
4. Check the direction of rotation and increase the speed of the motorslowly.
5. Set the speed and let the journal run for about half an hour until the oil in the bearing is warmed up and check the steady oil levels at varioustapings.
6. Add the required loads and keep the balancing rod in horizontal position by moving balancing weight "J" on the rod and observe the steadylevels.

7. When the manometer levels have settled down, take the pressure readings on 1 to 12 manometer tubes. For circumferential pressure distribution and A-B-12-C-D tubes for axial pressuredistribution.
8. Repeat the experiment for various speeds and loads.
9. After the test is over set dimmer to zero position and switch off mainsupply.
10. Keep the oil tank at lower most position so that there will be no leakage in the idleperiod.

6.9 Graphs

1. Graph to be plotted for pressure head of oil above supply head in cm. of oil, at angular intervals of 300 of oil film. The angular interval position are measured clockwise, commencing with position marked "1" inFig.
2. Graph is drawn for theoretical and experimental pressure curves for journal N1 = NRPM.
3. Graph is plotted for experimental pressure curves along the length of bearing at these speeds.

6.10 TYPICAL CALCULATION:

These calculations are based on sample readings and will differ from actual results and calculations for different unit. Data used in calculation is not pertaining to the actual unit supplied.
The method of drawing the theoretical Somerfield pressure curve is as follows: Consider pressure curve for N1 = N RPM.

- Select two points A and B on the experimental pressure curve of equal pressure and 180^0apart.
- Note that for any pressure curve there will be only one such pair of points is possible. These two points A and B from the axis$P{-}P_0 = 0$for the Somerfieldcurve.
- Of these two points take the point which is maximum thickness of oil film and take $\theta = 0$ to pass through thispoint.
- From the graph determine the point of maximum pressure (P – P0) max. in this case$\theta = 206^0 = -3n/2 + n^2$ n = 0.8
  Also $176 = \dfrac{-Ksin206^0(2 + 0.8Cos206^0)}{1 + 0.8Cos206^0}$ k=24.5
- Now plot the curve P - P_0=(with B as origin)

Load on the bearing
Total vertical load on bearing at NRPM.
= Dry weight of Bearing + Weight added + Weight of balancing load.
= 1.375 + 2 x 0.150 + added weight nil.
= 1.675 Kg.
Referring to fig. the mean positive pressure head of the oil above supply head.
= (35.5 + 24 +18 + 12 + 8+ 5 + 2 + 60 + 177 + 130) /10.
= 45.5 cm.
Load carried by oil pressure on projected area of bearing

= 45.5 x Density of oil x (2 R) L.
= 45.5 x 0.8539 x 5.5 x 6.8.
= 1.450 kg.
The underlined figures are recorded from graph and balanced are practical result.
Maximum theoretical load on journal is **Table 1:**
Typical Results w. r. t. manometer tubes.

Sr.no	Tube no.	Pressure Head in cm.

Table 2: PRESSURE HEAD OF OIL FILM ABOVE HEAD = (P – Ps) cm.
Shaft speed= RPM.

Sr.no	Tube no.	Pressure Head in cm.

6.11 Observations:

The Somerfield pressure function agrees with the experimental pressure curve within reasonable limits as indicated in Fig. Any deviations between the experimental and theoretical curves can be due to –

1. Human error in taking readings, for example in deciding whether or not the oil levels in the manometer are absolutely steady before takingreading.

2. The theoretical analysis is based on the assumption that the thickness of the oil film $h = \delta + eCos\theta$ which is true only if the radial clearance is very small. In practical journal bearings this assumption is true but in this test rig θ= 2.5 mm. which is very large. This has been purposely done so that the oil film profile is clearlyvisible.

3. The total weight of the bearing is = 1.375 Kg. It can be seen that the oil film in the bearing does not carry this full weight, a part of weight appears to be taken by the seal, and the flexible plastic tubes attached to thebearing.

6.12 Results:

6.13 PostLab Preperation

6.13.1 Viva Questions:

1. What is the formuale to calculate pressure head of oil film?

2. What are balancing forces?

3. write a short note on reciprocating masses?

6.13.2 Furthur Probing Experiments

1. The moment of the force is the product of the force and the perpendicular distance of the axis and the point of action of the force. Is this also true for rolling?

2. Where we can find journal bearing in an automobile?

LAB-6 LONGITUDINAL VIBRATION

7.1 Introduction

One end of open coil spring is fixed to the nut having a hole which itself is mounted on a MS strip fixed on one side of the main frame. The lower end of the spring is attached to the platform carrying the weights. The stiffness of the spring can be finding out by varying the weights on the platform and by measuring the deflection of the spring. The time period of vibrations can be calculated by measuring the nos. of oscillation and time taken by them.

7.2 Prelab Preparation:

Get complete detail of Springs and there stiffness and also how test rig works.
Read Appendix B and Appendix C of this manual, paying particular attention to the reason for doing this lab. Prior to coming to lab class, need to follow the below objective and answer the preLab Questions.

7.3 Objective

To study the longitudinal vibration of helical spring and to determine the frequency and time period of oscillation theoretically and actually by experiment.

7.4 Prelab Questions:

1. When a body is subjected to transverse vibrations, the stress induced in a body will be?
2. The ratio of the maximum displacement of the forced vibration to the deflection due to the static force is known as.
3. The natural frequency (in Hz) of free longitudinal vibrations is equal to?
4. Define resonance.

7.5 PreLab Experiment

7.5.1 Equipment needed

Longitudinal Vibration of Helical Spring testrig

7.6 Procedure

1. Fix one end of the helical spring to upperscrew.
2. Determine freelength.

3. Put some weight to platform and note down thedeflection.
4. Stretch the spring through some distance andrelease.
5. Count the time requiredin Sec. for say 10, 20 oscillations.
6. Determine the actualperiod.
7. Repeat the procedure for differentweights.

7.7 Obsercation:

CALCULATION TABLE - 1:

Sr. no	Wt. Attached, W.kg	Deflection in Spring cm.	Stiffness K Kg/cm	Mean Stiffness K Kg/cm

7.8 Nomenclature:

K	=	Stiffness of the spring
W	=	Weight applied
δ km	=	Deflection of the spring.

g = Acceleration due to gravity
n = No. of oscillations.
t = Time taken by "n" oscillation
T_{act} = Actual time period
T_{theo} = Theoretical time
f_{act} = period Actual
f_{theo} = frequency Theoretical

7.9 Results

7.10 PostLab Preperation

7.10.1 Viva Questions:

1. Define transverse and longitudinal wave?
2. Define the frequency?
3. Define stiffness?

7.10.2 Furthur Probing Experiments

1. Define the number of degrees of freedom of a vibration system?
2. What is the unit of spring stiffness?

LAB-7 VIBRATION ANALYSIS OF SHAFT

8.1 Introduction

This apparatus is developed for the demonstration of whirling phenomenon. The shaft can be tested for different end conditions.
The apparatus consists of a frame to support its driving motor, end fixing and sliding blocks etc. A special design is provided to clear out the effects of bearings of motor spindle from those of testing shafts. The special design features of this equipment are as follows.
A) Coupling – A flexible shaft is used to drive the test shaft from motor.
B) Ball Bearing Fixing Ends–
These ends fix the shafts while it rotates. The shaft can be replaced within short time with the help of this unit. The fixing ends provide change of end fixing condition of the rotating shaft as per the requirement.

8.2 Prelab Preparation:

Read Appendix B and Appendix C of this manual, paying particular attention to the reason for doing this lab. Prior to coming to lab class, need to follow the below objective and answer the preLab Questions.

8.3 Objective

To determine the frequency of different shafts.

8.3.1 Prelab Questions:

1. Define resonance.
2. Define Torsional viberation
3. Define longitudinal vibrations.

8.4 Equipment needed

Vibration Analysis of Shaft testrig.

8.5 Theory:

SHAFT SUPPLIED WITH THE EQUIPMENT:
Polishing spring steel shafts are supplied with the machine, the dimensions being as under,

Shaft No.	Diameter in mm	Length in inch (Approximately in cm)
1	4mm	35.5”, (90 cm)
2	6mm	35.5”, (90 cm)
3	8mm	35.5”, (90 cm)

8.6 Procedure

At motor end as well as tail end different bearing blocks can be fixed which are as follows,

1. Supported end condition – Make use of end block with single self aligningbearing.
2. Fixed end conditionx – Make use of end block with doublebearing.
3. Guards D1, D2 and D3 –
4. The guards can be fixed at any position on the supporting frame which fits on the side supports. Rotating shafts are to be fitted in blocks in A and B stands.
5. SPEED CONTROL OF DRIVING MOTOR –
6. The driving motor is 240 volts, frictional HP, 5000 rpm, 50 Hz, and speed control unit is a Dimmerstat of 240 volts, 2 Amp. 50Hz.
7. MEASUREMENT OF SPEED –
8. To measure the speed of the rotating shaft a simple Tachometer may be used (will not be supplied with the equipment) on the opposite side of the shaft extension of the motor.
9. Whirling of elastic shaft –
10. If, L = Length of the shaft incm.
11. E = Young’s Modulus Gpa = 73 in torsion and 193Gpa in tension I = 2nd moment of inertia of the shaft cm4.
12. W = Weight of the shaft per unit length Kg /cm. g = Acceleration due to gravity in m / sec2 = 9.81
13. Then the frequency of vibration for the various modes is given by the equation, $f = kx\sqrt{EIg}$

Sr.No.	End Conditions	Value of k	
		1st mode	2nd mode
1	Supported, Supported	1.57	6.28
2	Fixed, Supported	2.45	9.80
3	Fixed, Fixed	3.56	14.24

Sr. No.	Shaft Dia.	I =cm4	W =Kg/cm
1	3/16” = 0.47 cm.	25.39 x 10-4	0.15 x 10-2
2	1/4” = 0.64 cm.	79.91 x 10-4	0.28 x 10-2
3	5/16” = 0.79 cm.	194.78 x 10-4	0.424 x 10-2

8.7 Precatutions

1. If the revolution of an unloaded shaft are gradually increased it will be found that a certain speed will be reached at which violent instability will occur, the shaft deflecting into a single bow and whirling round like a skipping rope. If this speed is maintained the deflection will become so large that shaft will be fractured, but if this speed is quickly run through the shaft will become straight again and run true until at another higher speed the same phenomenon will occur, the deflection now however, being in a double bow and so on. Such speeds are called critical speeds of whirling.

2. It is advisable to increase the speed of shaft rapidly and pass through the critical speed first rather than observing the 1st critical speed which increases the speed of rotation slowly. In this process there is possibility that the amplitude of vibration will increase suddenly bringing the failure of theshaft.

3. If however the shaft speed is taken to maximum first and then slowly reduced, (thus not allowing time to build-up the amplitude of vibration at resonance) higher mode will be observed first and the corresponding speed noted and then by reducing the speed further the next mode of lower frequency can be observed without any danger of rise in amplitude as the speed is being decreased and the inertia forces are smaller in comparison with the bending spring forces hence possibility of build up dangerous amplitudes at resonance or near resonance is avoided.

4. Thus it can be seen that it is a destructive test of shafts and it is observed that the elastic behavior of the shaft material changes a little after testing it for a few times and it is advisable therefore, to use fresh shaft samplesafterwards.

5. Fix the apparatus firmly on the suitablefoundation.

8.8 TYPICAL TEST OBSERVATION:

1. Both ends of shafts free (Support) 1st and 2nd mode of vibration can be observed on shafts with 3/16": dia. And $\frac{1}{4}$"dia.

2. One end of shaft fixed and the other free, 1st and 2nd mode of vibration can be observed on the shaft with 3/16"dia.

3. Both ends of shaft fixed – 2nd mode of vibration cannot be observed on any of the shafts as the speeds are very high and hence beyond the range of theapparatus.

4. There is difference between theoretical speed of whirling and actual speed observed, due to following reasons:

   (a) The end conditions are not as exact as assumed intheory.

   (b) Pressure of damping at the endbearings.

   (c) Assumptions made in theoreticalpredictions.

   (d) Lack of knowledge of exact properties of shaftmaterial.

   (e) A uniformly loaded shaft has, theoretically infinite no. of natural frequencies of transverse vibration for fundamental mode observation of the first mode of whirling is therefore not so defined and thus difficult 2nd can be very easilyobserved.

8.9 Results:

8.10 PostLab Preperation

8.10.1 Viva Questions:

1. Name different types of vibrations.
2. Name different types of free vibrations
3. What is the difference between a vibration isolator and a vibration absorber?

8.10.2 Furthur Probing Experiments

1. Define time period related to vibratory motion
2. Define time cycle related to vibratory motion

LAB-8 MECHANISM

9.1 Introduction

Geneva mechanism is commonly used indexing mechanism where an intermittent motion is required. The Inverse Geneva mechanism, which is a variation of the Geneva mechanism, is used where the wheel has to rotate in the same Direction as crank. It requires less radial space and the locking device can be a circular segment attached to the crank that locks by wiping against a built up rim on the periphery of the wheel.

9.2 Prelab Preparation:

This experiment is to be to study a progressive tool and perform blanking and piercing operations. To determine the punching force and blanking force theoretically and compare the same with obtained readings. So, the working of Simple and compound machine and the components available for the machine and procedure of the manufacture. So how the welding is been done can be studied on course AMEB05 so before doing the experiment be prepared with the prelab preparation of washers and other sheets punching at a single step.

9.3 Objective

The experiment is to study a progressive tool and perform blanking and piercing operations. To determine the punching force and blanking force theoretically and compare the same with obtained readings

9.4 Prelab Questions:

1. Define machine & structure.
2. Concept of kinematics links, pairs, chains & mechanism.
3. Grashofs criterion.

9.5 In Lab Experiment

9.5.1 Equipment needed

- Double Slider CrankMechanism
- Geneva Mechanism

9.6 Theory

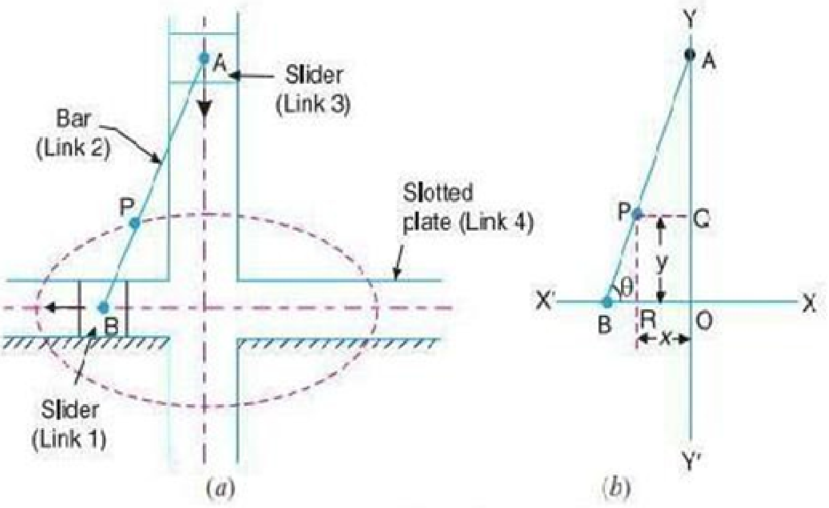
DOUBLE SLIDER CRANK MECHANISM

Double Slider Crank Chain A four bar chain having two turning and two sliding pairs such that two pairs of the same kind are adjacent is known as double slider crank chain.

Inversions of Double slider Crank chain: It consists of two sliding pairs and two turning pairs. They are three important inversions of double slider crank chain. 1) Elliptical trammel. 2) Scotch yoke mechanism. 3) Oldham„s Coupling.

1. Elliptical Trammel:

This is an instrument for drawing ellipses. Here the slotted link is fixed. The sliding block A and B in vertical and horizontal slots respectively. The end R generates an ellipse with the displacement of sliders A and B.



The co-ordinates of the point R are x and y. From the fig. $cos\theta = x$. OR and $Sin\theta = y.OQ$
Squaring and adding (i) and (ii) we get

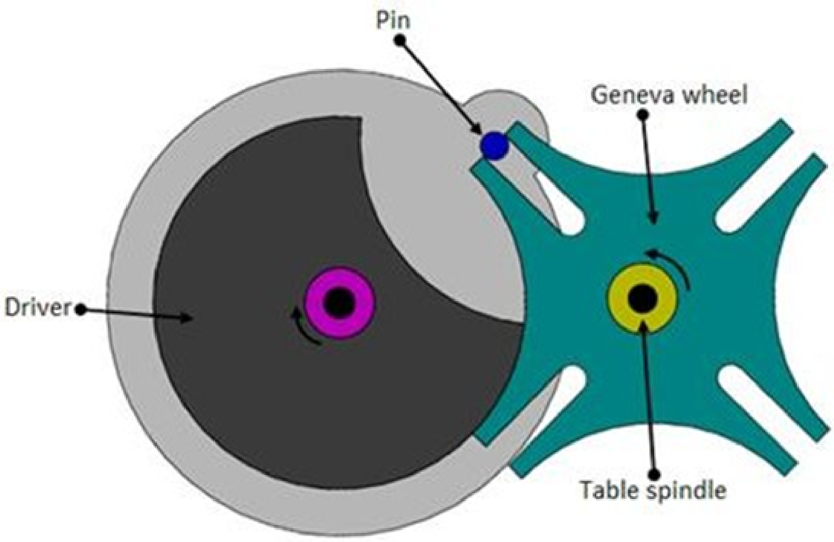
The equation is that of an ellipse, hence the instrument traces an ellipse. Path traced

2. Scotch yoke mechanism: This mechanism, the slider A is fixed. When AB rotates above A, the slider B reciprocates in the vertical slot. The mechanism is used to convert rotary to reciprocating mechanism. Consider fig a and b.

GENEVA MECHANISM

INTRODUCTION

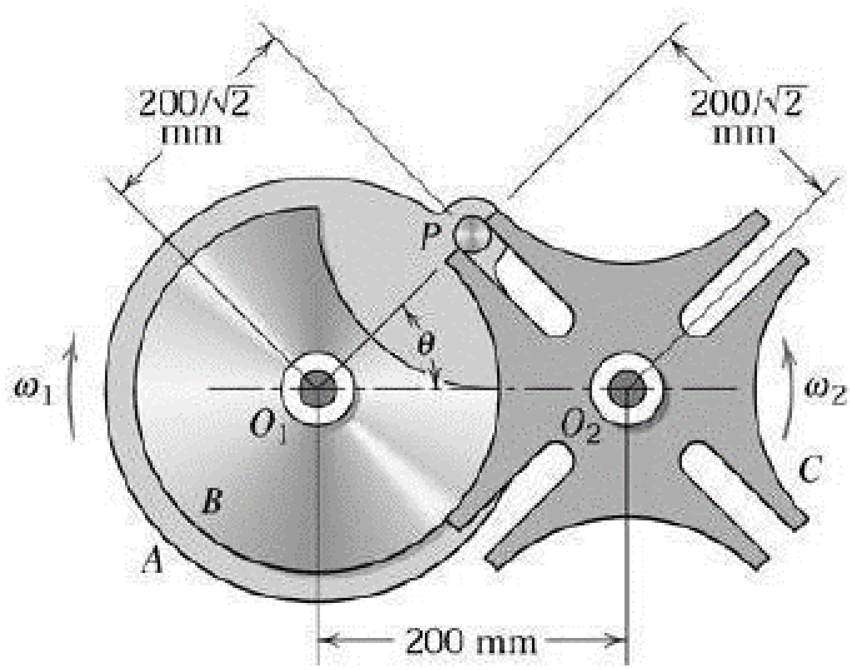
The Geneva drive or Maltese cross is a gear mechanism that translates a continuous rotation movement into intermittent rotary motion. The rotating drive wheel is usually equipped with a pin that reaches into a slot located in the other wheel (driven wheel) that advances it by one step at a time.



CLASSIFICATION OF GENEVA MECHANISM

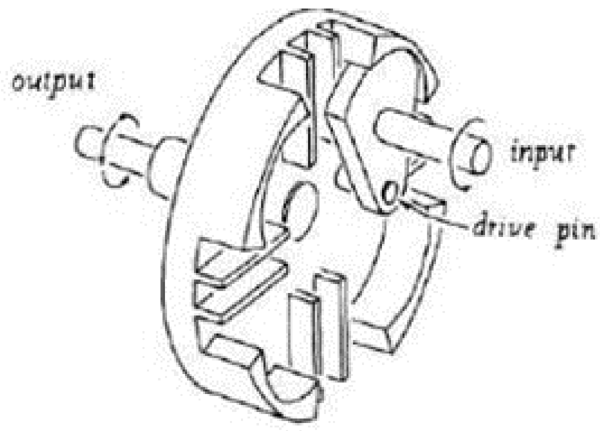
1. External Gear Mechanism

In this type of mechanism, the Geneva cross is connected with cam drive externally which is the most popular and can withstand higher mechanical stresses. The driver grooves lock the driven wheel pins during dwell. During movement, the driver pin with the driver-wheel slot.



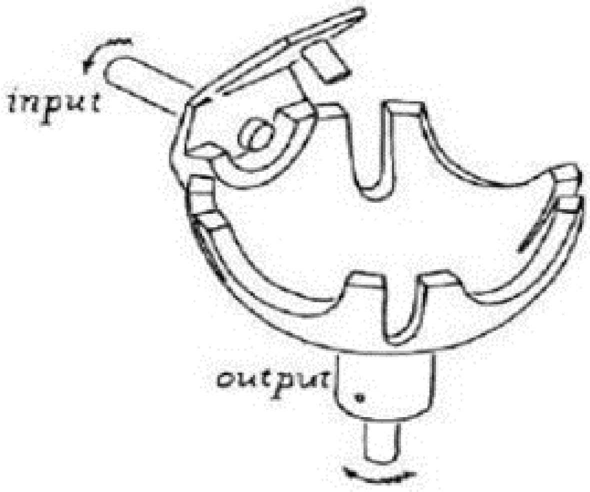
2. Internal Gear Mechanism

In this type of mechanism the Geneva cross and cam drive are connected internally in the closed box. The driver and driven wheel rotate in same direction. The duration of dwell I more the 180o of driver rotation.



3. Spherical Geneva Mechanism

In this type of mechanism, the Geneva cross is in spherical shape and cam drive is connected in externally, which is extremely rare. The driver and driven wheel are on perpendicular shafts. The duration of dwell is exactly 180o of driven rotation.

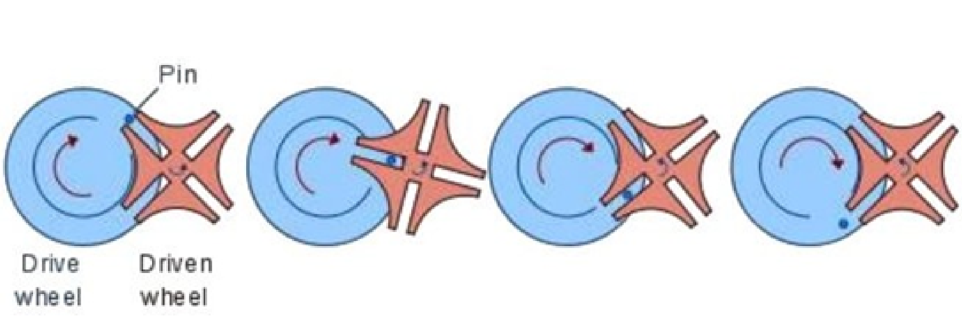


Working of Geneva Mechanism

In the most common arrangement, the driven wheel has four slots and thus advances by one step of 90 degree for each rotation of the drive wheel. If the driven wheel has n slots, it advances by 360 degree per n full rotation of the drive wheel.

Geneva are also combined with variety of other mechanism, such as four bar linkages, clutch-brake combination, Non- circular gears etc to modify the motion curves and dwell motion ratios obtained from pure Geneva.

perpendicular shafts. The duration of dwell is exactly 180o of driven rotation.



Advantages of Geneva Mechanism

a) Geneva Mechanism may be the simplest and least Expensive of all intermittent motion mechanism.
b) They come in a wide variety of sizes, ranging from those used in instrument, to those used in machine tools to index spindle carriers weighing several tons.
c) They have good motion curves characteristics compared to ratchets, but exhibit more “jerk” or instantaneous change in acceleration, than better cam systems.

Disadvantages of Geneva Mechanism

a) The Geneva is not a versatile mechanism and produce jerk.
b) The ratio of dwell period to motion is also established once the no of dwells per revolution has been selected.
c) All Geneva acceleration curves start and end with finite acceleration and deceleration.

Application of Geneva Mechanism

- It is applicable in the production industries and automobile industries for mass production.
- Modern film projectors may also use an electronically controlled indexing mechanism or stepper motor, which allows for fast-forwarding the film.
- Geneva wheels having the form of the driven wheel were also used in mechanism watches, but not in a drive, rather to limil the tension of the spring, such that it would operate only in the range where its elastic force is nearly linear.
- Indexing table in assembly lines, tool changers for CNC machine, and so on.

9.7 Procedure

9.8 Results

9.9 PostLab Preperation

9.9.1 Viva Questions:

1. Types & examples of constrained motion.
2. Classification & examples of all the kinematics links, pairs, chains & mechanism.
3. What are the advantages and disadvantages Geneva mechanisum?

9.9.2 Furthur Probing Experiments

1. What are the few applications of Geneva mechanisum?
2. What are the best mechanisums used in an mechanical industry?

LAB-9 GEAR BOX

10.1 Introduction

The gearbox is a mechanical device used to increase the output torque or to change the speed (RPM) of a motor. The shaft of the motor is connected to one end of the gearbox and through the internal configuration of gears of a gearbox, provides a given output torque and speed determined by the gear ratio.

10.2 Prelab Preparation:

Need to have knowledge of gear rations and the purpose of Gearbox.
Read Appendix B and Appendix C of this manual, paying particular attention to the reason for doing this lab. Prior to coming to lab class, need to follow the below objective and answer the preLab Questions.

10.3 Objective

To study the Gear Box assembly

10.4 Prelab Questions:

1. Define addendum circle.
2. Define working depth.
3. State law of gearing.

10.5 In Lab Experiment

10.5.1 Equipment needed

Automobile gear box

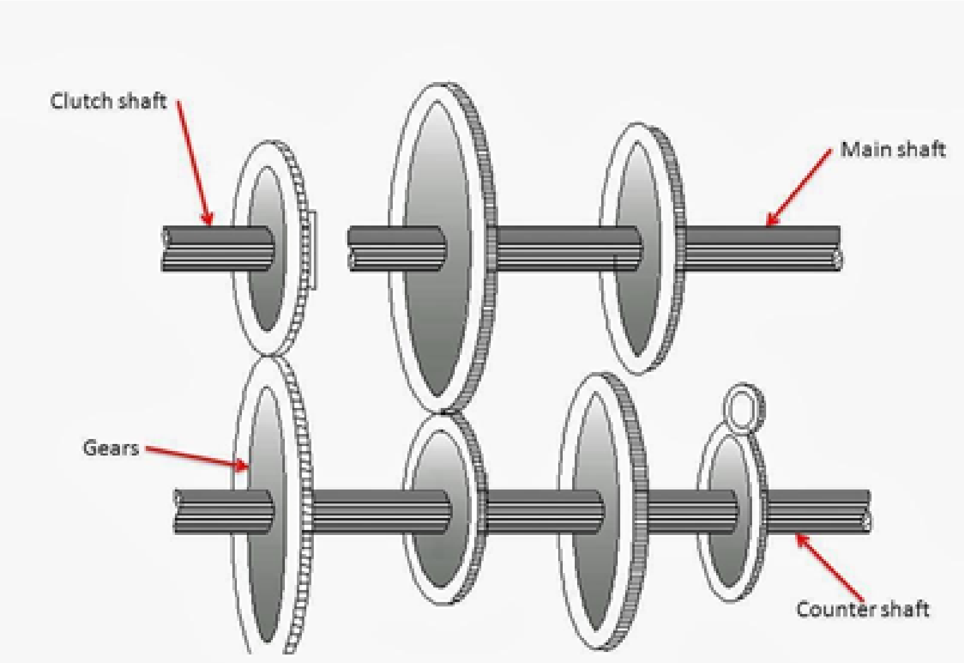
10.6 Theory

FUNCTION OF TRANSMISSION BOX (GEAR BOX) IN AUTOMOBILE:
The transmission box which is also known as the gear box is the second element of the power train in an automobile. It is used to change the speed and torque of vehicle according to variety of road and load conditions. Transmission box change the engine speed into torque when climbing hills and when the vehicle required. Sometimes it is known as torque converter. Main functions of a gear box are as follow:
1. Provide the torque needed to move the vehicle under a variety of road and load conditions.

It does this by changing the gear ratio between the engine crankshaft and vehicle drive wheels.
2. Be shifted into reverse so the vehicle can move backward.
3. Be shifted into neutral for starting the engine.

MAIN COMPONENTS OF A GEAR BOX:

In any device two or more component works together and full fills the required function. In a transmission box four components are required to fulfil its function. These components are-



Main parts of gear box

a) Counter shaft:

Counter shaft is a shaft which connects with the clutch shaft directly. It contains the gear which connects it to the clutch shaft as well as the main shaft. It may be run at the engine speed or at lower than engine speed according to gear ratio.

b) Main shaft:

It is the shaft which runs at the vehicle speed. It carries power from the counter shaft by use of gears and according to the gear ratio, it runs at different speed and torque compares to counter shaft. One end of this shaft is connects with the universal shaft.

c) Gears:

Gears are used to transmit the power from one shaft to another. They are most useful component of gear box because the variation is torque of counter shaft and main shaft is depends on the gear ratio. The gear ratio is the ratio of the driven gear teeth to the driving gear teeth. If gear ratio is large than one, the main shaft revolves at lower speed than the counter shaft and the torque of the main shaft is higher than the counter shaft. On other hand if the gear ratio is less than one, than the main shaft revolves at higher speed than the counter shaft and the torque of the main shaft is lower than the counter shaft. A small car gear box contains four speed gear ratio and one reverse gear.

d) Bearings:

Whenever the rotary motion encounters, bearings are required to support the revolving part and reduce the friction. In the gear box both counter and main shaft are supported by the bearing.

WORKING OF A PRINCIPLE GEAR BOX:

In a gear box, the counter shaft is mashed to the clutch with a use of a couple of gears. So the counter shaft is always in running condition. When the counter shaft is bring in contact with the main shaft by use of meshing gears, the main shaft start to rotate according to the gear ratio. When driver want to change the gear ratio, simply press the clutch pedal which disconnect the counter shaft with engine and connect the main shaft with counter shaft by another gear ratio by use of gearshift lever. In an gear box, the gear teeth and other moving metal must not touch. They must be continuously separated by a thin film of lubricant. This prevents excessive wear and early failure. There for a gearbox runs partially filled with lubricant oil.

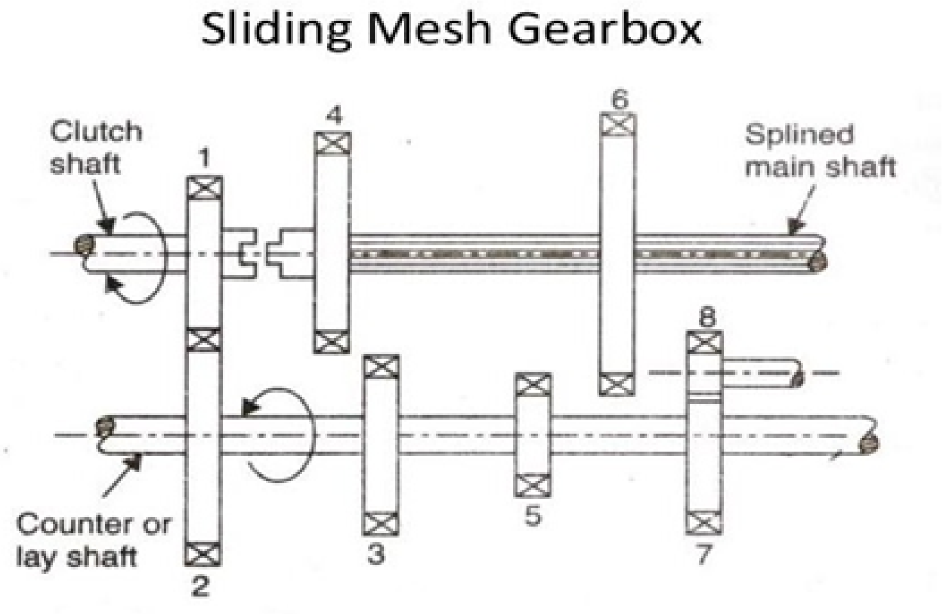
SELECTIVE TYPE GEAR BOX

It is the transmission in which any speed may be selected from the neutral position. In this type of transmission neutral position has to be obtained before selecting any forward or reverse gear. Some selective type gear boxes are,

1. Sliding mesh gear box
2. Constant mesh gear box with positive dog clutch.
3. Constant mesh gear box with synchromesh device.

1. SLIDING MESH GEAR BOX

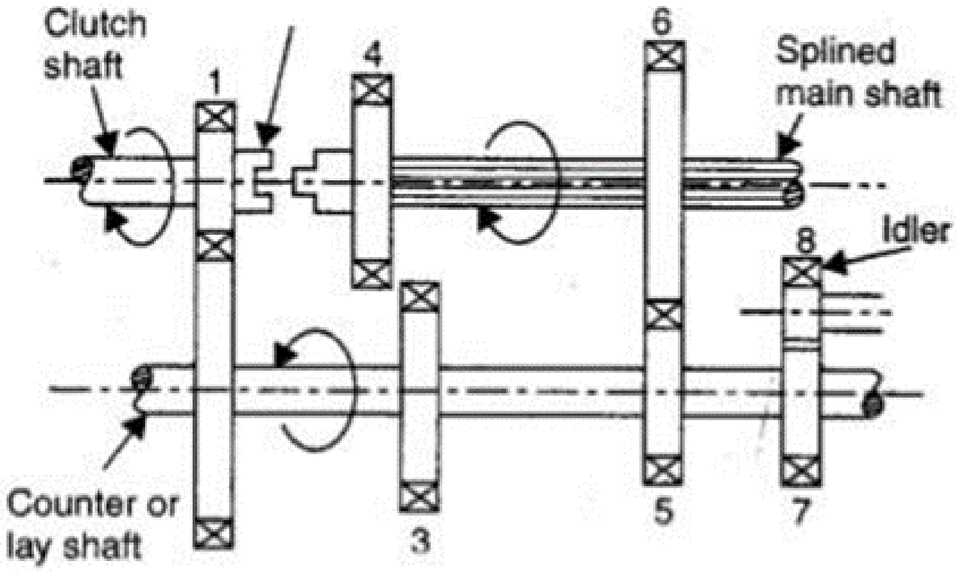
a) It is the simplest and oldest type of gear box.
b) The clutch gear is rigidly fixed to the clutch shaft.
c) The clutch gear always remains connected to the drive gear of countershaft.
d) The other lay shaft gears are also rigidly fixed with it.
e) Two gears are mounted on the main shaft and can be sliding by shifter yoke when shifter is operated.
f) One gear is second & top speed gear and the other is the first and reverse speed gears. All gears used are spur gears.
g) A reverse idler gear is mounted on another shaft and always remains connected to reverse gear of counter shaft.



First Gear

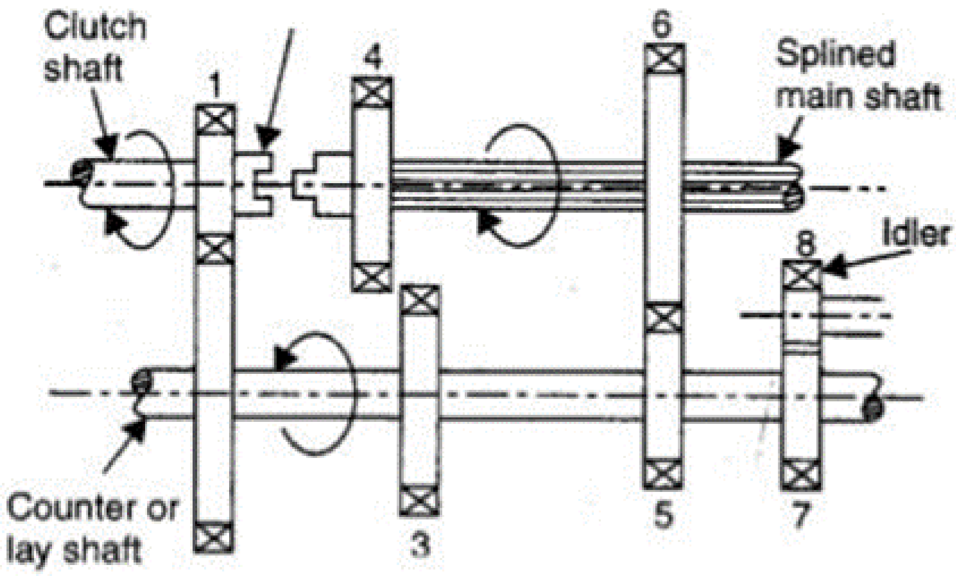
a) By operating gearshift lever, the larger gear on main shaft is made to slide and mesh with

first gear of countershaft.
b) The main shaft t urns in the same direction as clutch shaft in the ratio of 3:1.



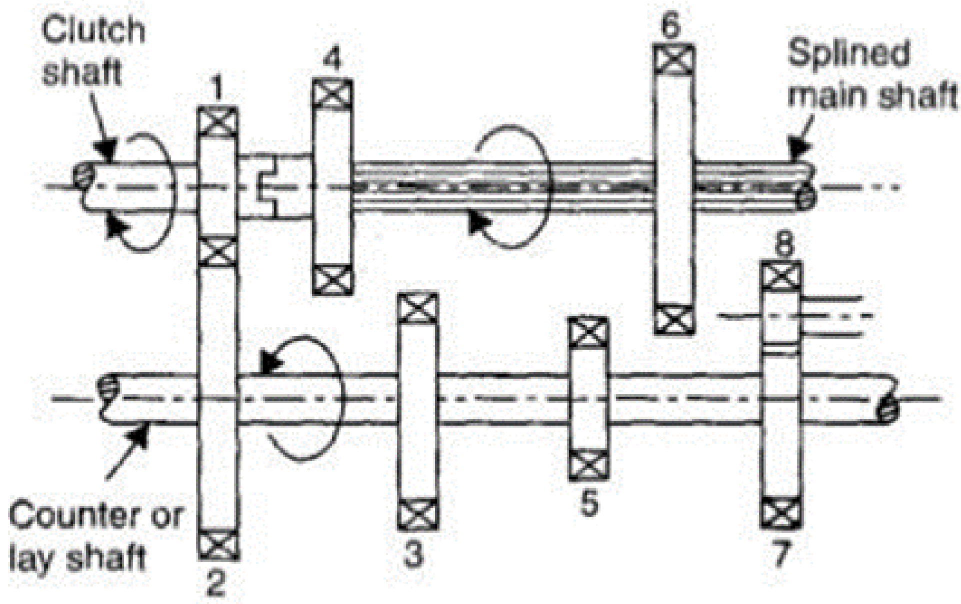
Second Gear

a) By operating gear shift lever, the smaller gear on the main shaft is made to slide and mesh with second gear of counter shaft.
b) A gear reduction of approximately 2:1 is obtained.



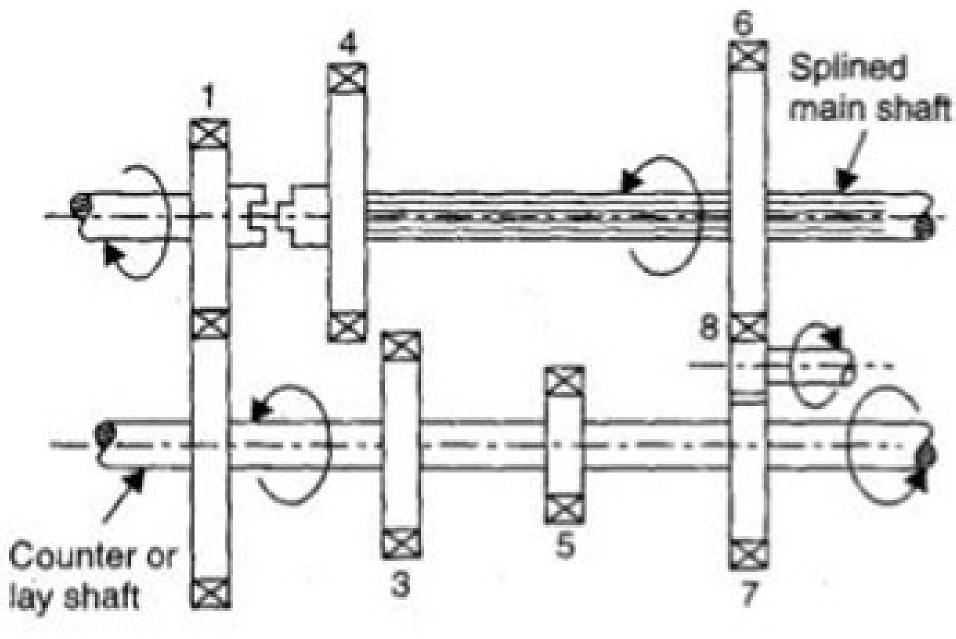
Top Gear

a) By operating gearshift lever, the combined second speed gear and top speed gear is forced axially against clutch shaft gear.
b) External teeth on clutch gear mesh with internal teeth on top gear and the gear ratio is 1:1.



Reverse Gear

a) By operating gearshift lever, the larger gear of main shaft is meshed with reverse idler gear.
b) The reverse idler gear is always on the mesh with counter shaft reverse gear. Interposing the idler gear, between reverse and main shaft gear, the main shaft turns in a direction opposite to clutch shaft.



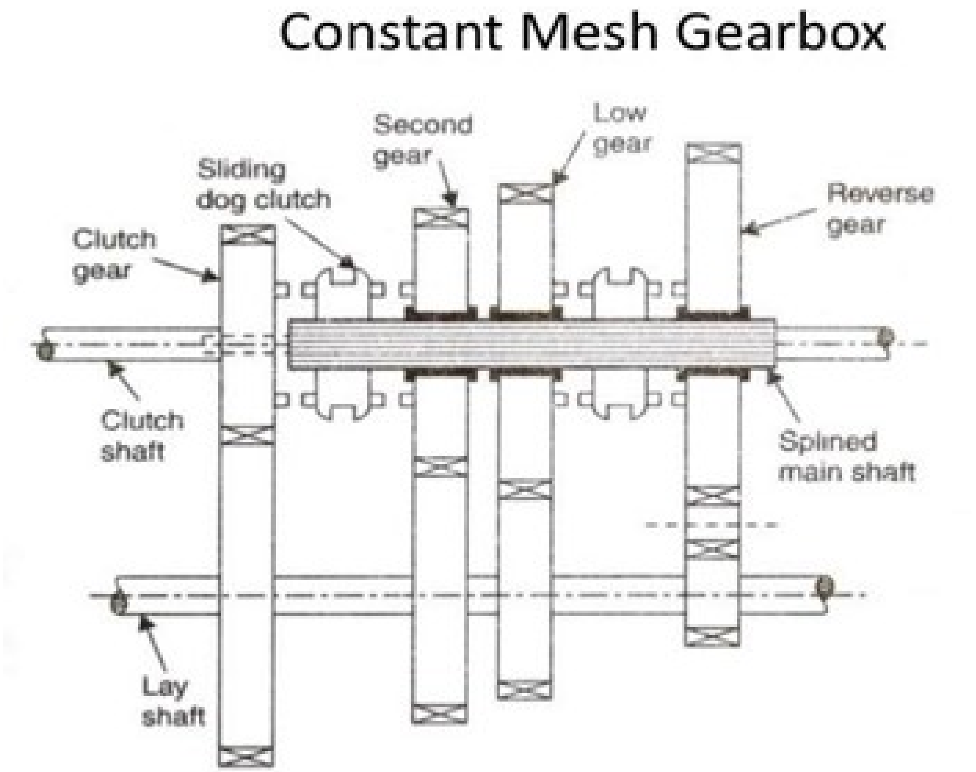
Neutral Gear

a) When engine is running and the clutch is engaged, clutch shaft gear drives the drive gear of the lay shaft and thus lay shaft also rotates.
b) But the main shaft remains stationary as no gears in main Shaft is engaged with lay shaft gears.

CONSTANT MESH GEAR BOX

a) In this type of gearbox, all the gears of the main shaft arein constant mesh with corresponding

gears of the countershaft.
b) The gears on the main shaft which are bushed are free to rotate.
c) The dog clutches are provided on main shaft.
d) The gears on the lay shaft are, however, fixed.
e) When the left Dog clutch is slide to the left by means of the selector mechanism, its teeth are engaged with those on the clutch gear and we get the direct gear.
f) The same dog clutch, however, when slide to right makes contact with the second gear and second gear is obtained.
g) Similarly movement of the right dog clutch to the left results in low gear and towards right in reverse gear. Usually the helical gears are used in constant mesh gearbox for smooth and noiseless operation.



Advantage over sliding mesh gear box

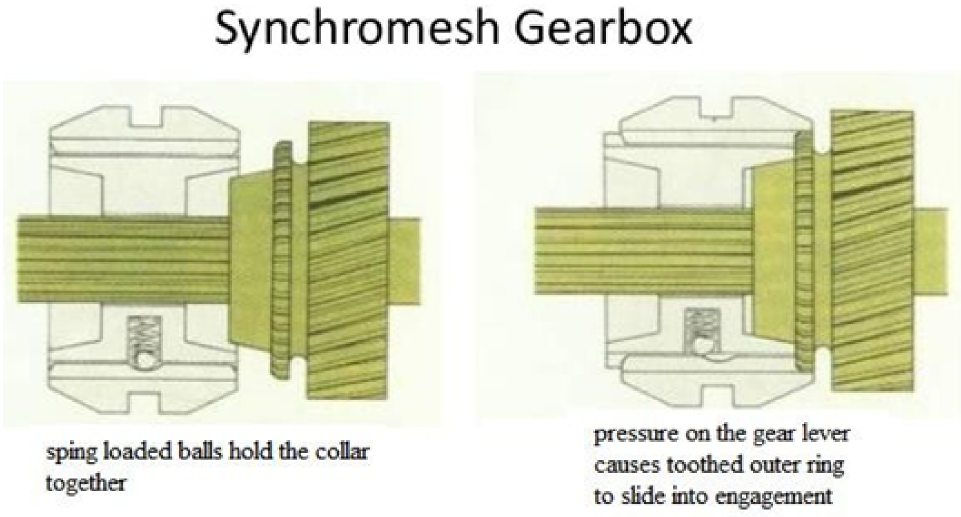
- Helical and herringbone gear can be used in these gear boxes and therefore, constant mesh gearboxes are quieter.
- Since the gears are engaged by dog clutches, if any damage occurs while engaging the gears, the dog unit members get damaged and not the gear wheels.

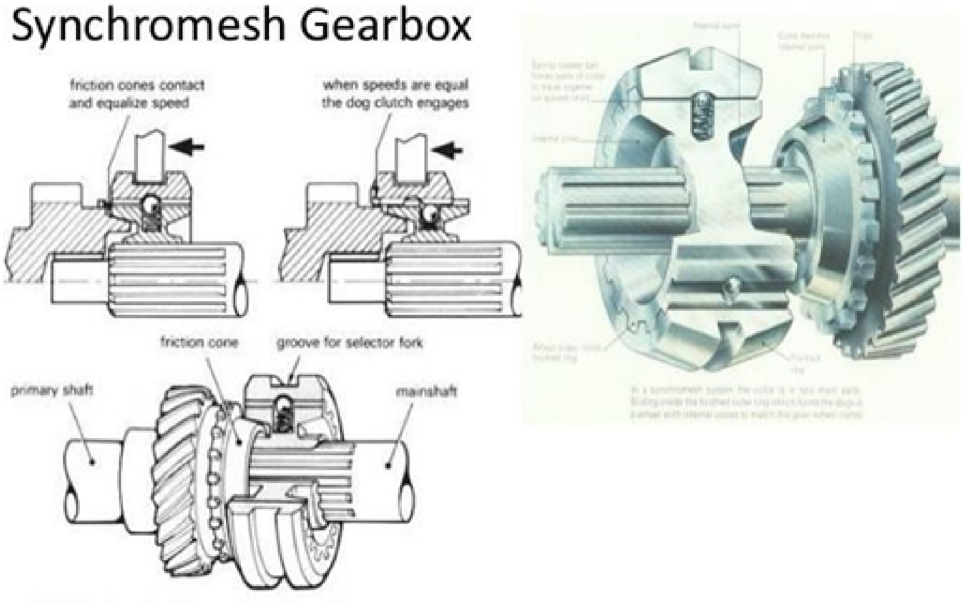
Double declutching

- Used for smooth downshifting.

2. SYNCHROMESH GEARBOX

This type of gearbox is similar to the constant mesh type gear box.
a) Instead of using dog clutches here synchronizers are used.
b) The modern cars use helical gears and synchromesh devices in gearboxes, that synchronize the rotation of gears that are about to be meshed





SYNCHRONIZERS

a) This type of gearbox is similar to the constant mesh type in that all the gears on the main shaft are in constant mesh with the corresponding gears on the lay shaft.
b) The gears on the lay shaft are fixed to it while those on the main shaft are free to rotate on the same.
c) Its working is also similar to the constant mesh type, but in the former there is one definite improvement over the latter.
d) This is the provision of synchromesh device which avoids the necessity of double- declutching.
e) The parts that ultimately are to be engaged are first brought into frictional contact, which equalizes their speed, after which these may be engaged smoothly.
f) Figure shows the construction and working of a synchromesh gearbox. In most of the cars, however, the synchromesh devices are not fitted to all the gears as is shown in this figure.
g) They are fitted only on the high gears and on the low and reverse gears ordinary dog clutches are only provided.
h) This is done to reduce the cost.

Note:-

The Model Gear Box Is Synchromesh Gear Box with 3 Forward and Single Reverse Gear.

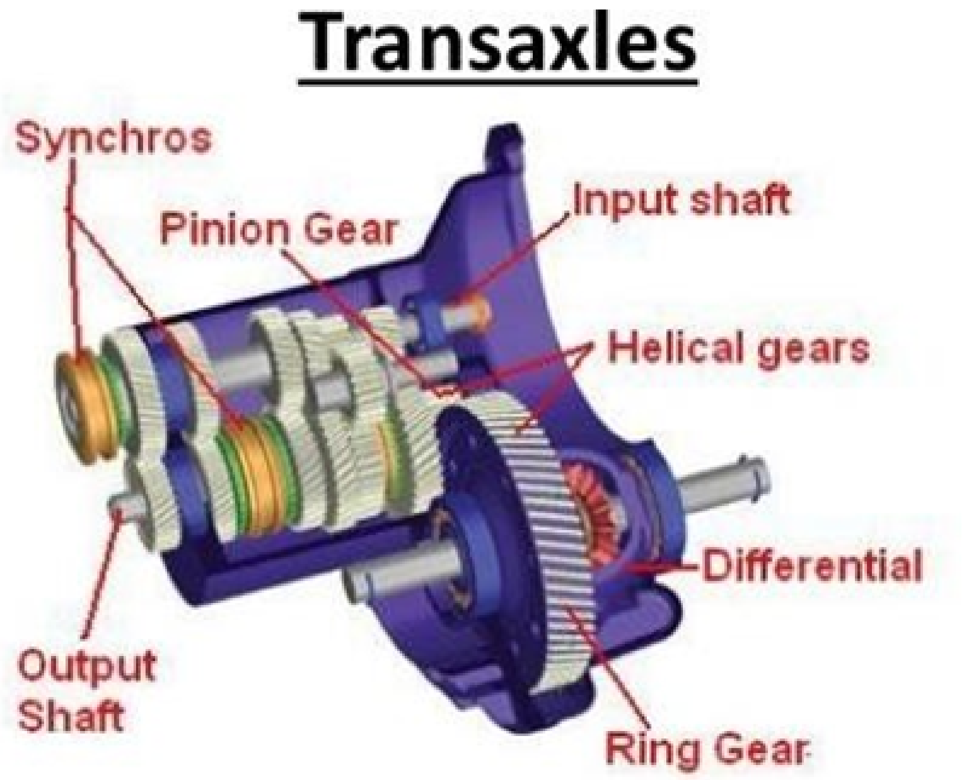
Some Other Transmission Used In Modern Automobile

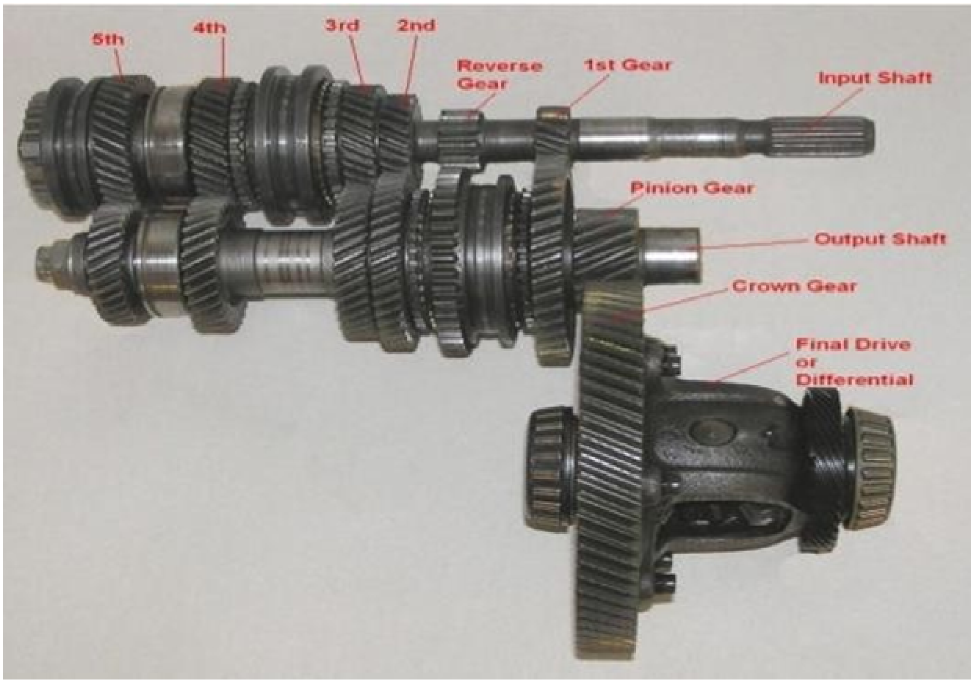
TRANSFER CASE

- Normally used in 4 wheel drive vehicles.
- Two speed transmission having ”low and high” rear ratios that can be engaged while in neutral position.
- Fixed after the gear box.
- Enables engagement and disengagement of 4 wheel drive.

TRANSAXLE GEAR BOX

- Have only 2 shafts.
- Used in vehicle with engine and drive on some side.
  - Font engine front wheel drive.
  - Rear engine rear wheel drive.
- Most commonly used.
- Gear box and differential in same housing.
- Combination of transmission and differential in one unit is called transaxle.
- Transaxles are both automatic and manual.





10.7 Procedure

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6

10.8 Result

10.9 PostLab Preperation

10.9.1 Viva Questions:

1. What is Reverted gear train?
2. Define speed ratio of gear device.
3. Where exactly gear box is used in machinary in convenction machine?

10.9.2 Furthur Probing Experiments

1. What exactly the purpose of gear box in mechanical machinary?
2. Why do we need Gear box in an automobile?

LAB-10 FREE AND FORCED VIBRATION OF CANTILEVER BEAM

11.1 Introduction

In this experiment, a slightly heavy rectangular section bar is supported at both ends in truinion fittings. Exciter unit with the weight platform can be clamped at any conventional position along the beam. Exciter unit is connected to the damper. Which provides the necessary damping.

DAMPING ARRANGEMENT:
1. Close the one hole of damper for light damping.
2. Close the two holes of damper for medium damping.
3. Close all the three holes of damper for heavy damping.

11.2 Prelab Preparation

Need to have good knowledge in types of beam and types of viberations.
Read Appendix B and Appendix C of this manual, paying particular attention to the reason for doing this lab. Prior to coming to lab class, need to follow the below objective and answer the preLab Questions.

11.3 Objective

To study the forced vibration of the beam for different damping.

11.4 Prelab Questions:

1. Define free vibrations.
2. Define forced vibrations.
3. Define torsional vibrations.
4. Define longitudinal vibrations.

11.5 In Lab Experiment

11.5.1 Equipment needed

- Vibration test rig
- Cantilever Beam
- Rubber hammer

11.6 EXPERIMENTAL PROCEDURE

1. Arrange the setup
2. Connect the exciter motor to control panel.
3. Start the motor and allow the system to vibrate.
4. Wait for 5 minutes for amplitude to build up for particular forcing frequency.
5. Adjust the position of strip chart recorder. Take the recorder of amplitude vs. Time on strip chart recorder by starting recorder motor.
6. Take record by changing forcing frequency for each damping.
7. Repeat the experiment for different damping.

11.7 GRAPH

- Plot the graph of amplitude Vs. Frequency for each damping

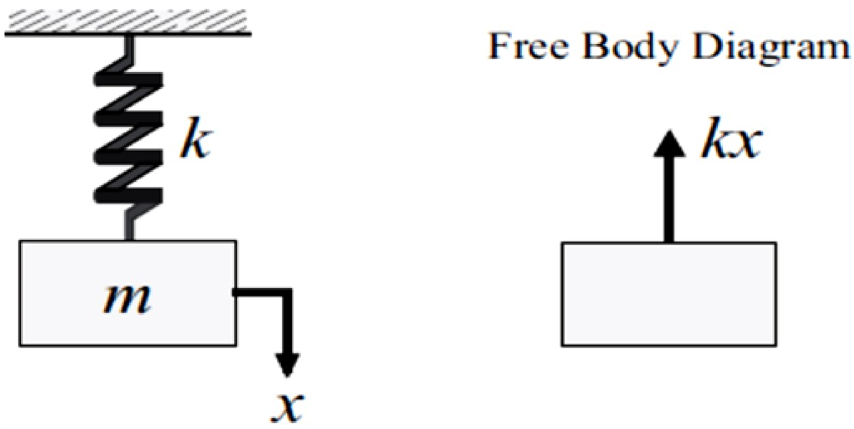


Figure 11.1: Spring-Mass System

11.8 OBSERVATION

Sr.no	Forcing Frequency	Amplitude
1		
2		
3		

11.9 Precautions

1. Do not run the motor at low voltage i.e. less than 180 volts.
2. Do not increase the speed at once.
3. Damper is always in perpendicular direction.
4. A motor bolts is properly tightly with weight.
5. A beam is proper tight in bearing with bolt.
6. Always keep the apparatus free from dust.

11.10 Results:

11.11 PostLab Preperation

11.11.1 Viva Questions:

1. Define frequency related to vibratory motion.
2. Define amplitude?
3. What is spring stiffness and its formuka?

11.11.2 Furthur Probing Experiments

1. Write few examples of free and forced vibrations
2. Automobile suspensions somes under which type viberations?