A REPORT ON

PROJECT BASED LEARNING (PBL)

for

Second Year and **Third** Year **Undergraduate Students** of **Mechanical and Automobile Engineering** Departments of **MES's Pillai College of Engineering, New Panvel**

for the **Academic Year** 2016-2017 (Even Semesters)

Objective—To enable the students to apply concepts of the present semester subjects (including those of previous semesters) in the form of a design project based on certain application. It is hoped that it shall eventually lead to a better learning experience as opposed to text-book learning.

A common topic is assigned to all students of the same year, to provide a common yardstick for comparison and enable healthy competition among the different teams. The students work in groups (maximum 5-6 students per group) and assign and distribute various aspects of work so as to realize the project based on a timeline of about 2 months. Queries and doubts are clarified by interactions with the PBL coordinators and subject experts. Student groups submit the PBL report during their demonstrations on a specified date in front of the faculty members.

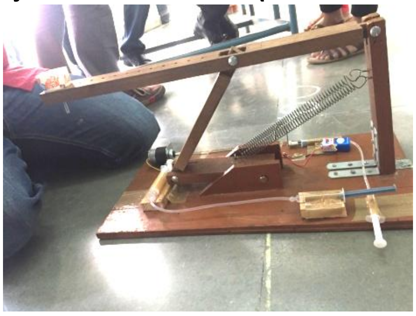
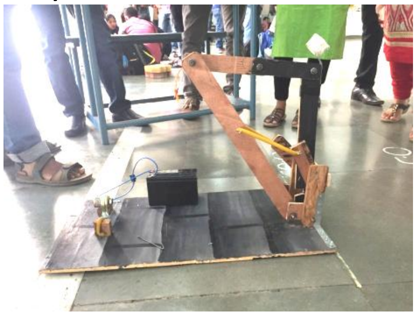
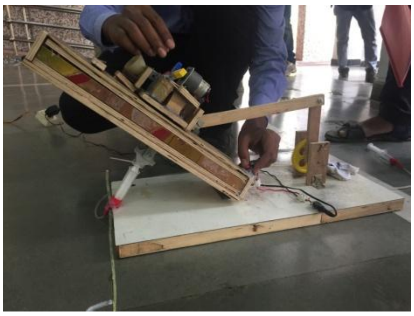
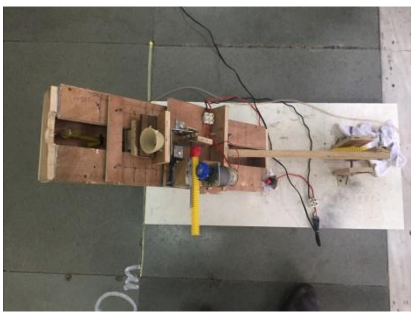
PBL Coordinators—M.Durga Rao and Amey Marathe

Judges for the PBL Demonstrations—All Mechanical and Automobile Engineering Faculty Members

PBL Topic for Second Year Mechanical/Automobile Engineering: CATAPULT

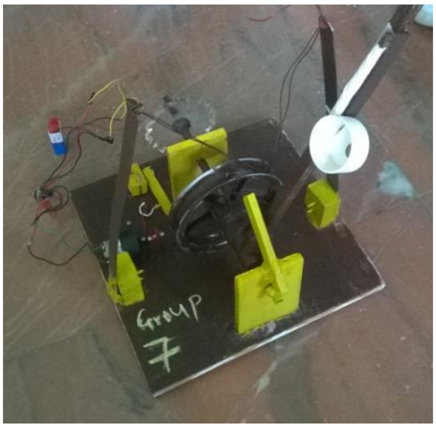
DESIGN and CONSTRUCT a Catapult, so that when the swing arm is pulled back to the desired angle and triggered/released, it propels a ball/mass forward. Loading of swing arm may be done by hand or by use of a motor. Once loaded, the triggering of the arm has to be done using electronic means. The ball/mass has to be considered from at least any two different classes of materials. The ball/mass is expected to land on a box or a bucket positioned at some arbitrary distance from it, in the very first bounce. The best design of catapult is the one that throws the ball in the box/bucket at various arbitrary positions, a maximum number of times out of the given 5 attempts. Variation in the distance by which ball/mass is thrown should be realized by changing at least 2 system parameters on an independent basis. One of the design constraints is that the catapult should use at least a 4-bar/link mechanism to realize the motion.

Some photos taken during the Catapult Project Demonstration (on 18 March 2017):




SE
Mech B



Group
7

Rubrics & Assessment Sheet for the topic CATAPULT (Second Year):

Mahatma Education Society's
PILLAI COLLEGE OF ENGINEERING, New Panvel
Department of Mechanical and Automobile Engineering
PROJECT BASED LEARNING (PBL) DEMONSTRATION – RUBRICS & ASSESSMENT SHEET

TOPIC: CATAPULT YEAR & CLASS: SE - MECHANICAL (B) Date of Demonstration: 18/03/2017

JUDGES: 1. Prof.______________ 2. Prof.__________ 3. Prof.____________ 4. Prof.____________

Signatures: ______________ ________________ __________________ _______________

STUDENT GROUP –

Name					
Roll No.					
Signature					

1. **Mass of balls used for conducting pre-demo tests:**
   m_1 = _____ kg, m_2 = _______kg.

2. **Max. Throw Distance Achieved** using m_1 & m_2 respectively (data from pre-demo tests) = ____&____ m.

3. **Loading of swing arm:** Manual ☐ Motor ☐

4. **Electronic triggering provided:** Yes ☐ No ☐
   If Yes, **Name of Electronic Component:** _____________

5. **Catapult Performance:**

Throw Distance (m)					
Successful ? Pls ✓ if Yes					

6. **Elastic Element used for generating Potential Energy:**
   Torsional Spring ☐ Tension/Compression Spring ☐
   Self weight of heavy mass ☐ Twisted Rope ☐
   Rubber Band ☐ Cantilever/Simply Supported Beam ☐
   Shaft in torsion ☐

7. **Stiffness of the Elastic Element** = ____________units (i.e., either **N/m** or **Nm/rad**)

8. **Schematic (Skeleton/Line Diagram) Representation of the mechanism:**

9. **Whether 4-bar (or higher number) chain used for the mechanism?** Yes ☐ No ☐
   (Note: Spring element should not be directly connected between swing arm & stationary link, else the other two links except stationary link—shall become redundant, hence may not be called a 4-bar chain).

10. **Two parameters/variables used to achieve variation in throw distance of ball (& used to create graphs for pre-demo tests):**
    ____ and
    ____

11. **Whether theoretical analysis (analytical estimate) of throw distance of ball done?** OR **Whether similar analysis (involving velocity and acceleration data of links) done, using software viz. SolidWorks etc.?**
    Yes ☐ No ☐

12. **Whether Experimental Runs/Tests performed (pre-demo):** Yes ☐ No ☐

13. **Construction Materials used:**
    ____

14. **Approx. Cost of the project (excluding man-hours):**
    Rs. ______________

15. **Whether Hard Copy of Report submitted?**
    Yes ☐ No ☐

16. **Whether Tabulated Cost Analysis included in the Report?** Yes ☐ No ☐

17. **Is the Catapult SAFE to use?** Yes ☐ No ☐

18. **Level of Difficulty of Design:** Good☐ Avg.☐ Poor☐

19. **Whether 'concept of Fluid Mechanics' included?**
    Yes ☐ No ☐

20. **Build Quality of Model:** (a) Rugged/Weak ☐/☐
    (b) Compact/Bulky ☐/☐
    (c) Aesthetics (Good/Poor) ☐/☐

21. **Overall Remarks / Rating:** (5-Best, 4-Good, 3-Avg., 2-Poor, 1-V.Poor/To Repeat) ☐

TW Marks Allocation: TOM-I: /5 MT: /3 IE: /3 MSP: /15 FM: /3

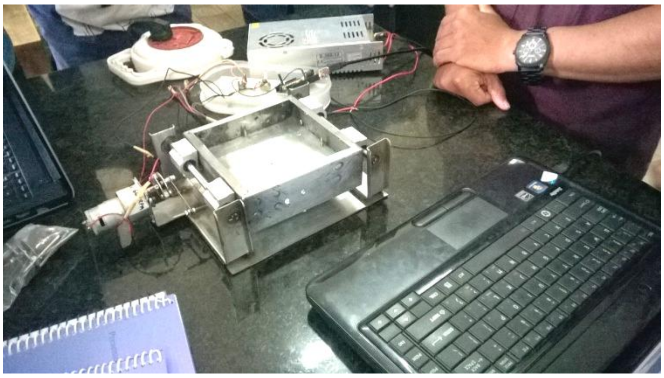
PBL Topic for Third Year Mechanical/Automobile Engineering: SHAKER TABLE

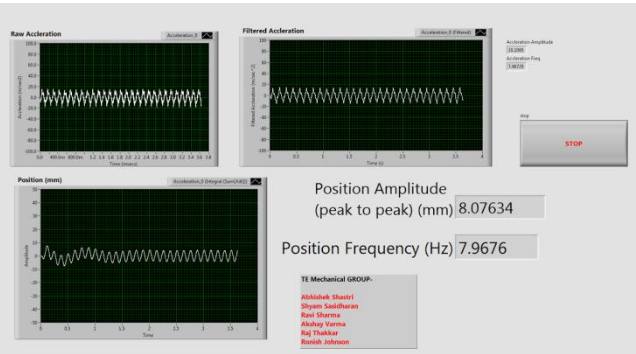
DESIGN and CONSTRUCT a general purpose, open-loop (no feedback control system of vibration signal), horizontal SHAKER TABLE, the end-use of which shall be made for excitation of model building structures and other objects, or for separation of mixture of powdered particles of different densities. It is useful for studying the effects of vibration on structures and developing better designs to resist/minimize the same.

Following are the rules framed for the Shaker Table: The excitation/shaking of shaker table should be realized either by pure mechanical means (linkages, or even combination of fluid power with links), or by using mechatronics devices. An existing range of mechanisms (in the syllabus/literature/internet) or an indigenous one may be used for the drive mechanism. The table may be excited by a command through a PC connection or a Smart Phone if required. Direction of movement: Shaking in any one direction (either of X-, Y- or Z-) is expected. The shaker should be able to produce vibrations of different frequencies (suggested frequency range: 0-10 Hz) with amplitudes of movement ranging from 0-1 cm. The vibration signal produced should be pure sinusoid (sine or cosine curve) and the test is of sine-sweep in nature. The shaker table should be 15 cm square shaped, and the material to be used is Aluminium (for uniformity in judging). An accelerometer (vibration sensor) with a DAQ (Data Acquisition System) and a PC with LabVIEW software shall be provided by the Institute during the demonstration, for recording and judging the accuracy of obtained signal.

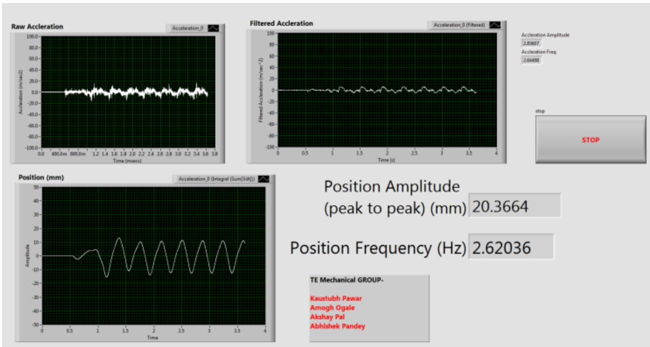
It is expected that the shaker table should be rigid for minimum deformation during vibration. This happens when its natural frequency (first) does not coincide with the excitation frequency (or resonance). For this, it is expected that the first natural frequency of the shaker table should be having a very high value. Students are encouraged to devise more than one different designs of the shaker table, so that it is very light (hence Aluminium) and also very rigid (light—since high natural frequency is expected, and rigid—for minimum shaker deformation). A high first natural frequency is expected since it shall increase the usable operating frequency range of the shaker table without causing resonance. The shaker table has to be designed as a thin plate (membrane) with stiffeners (structural ribs) to realize the requirements as stated above. The surface of the table is expected to remain as flat as possible. It can be achieved in a number of ways. The different designs should be modeled in CAD software and analyzed in FEA software available with the Institute. Expected parameters from the simulation study include—modal analysis (first mode shape and amplitudes of deformation) and first natural frequency, apart from other parameters viz., stresses etc.







Output Sample Reading 1



Output Sample Reading 2

Rubrics & Assessment Sheet for the topic SHAKER TABLE (Third Year):

Mahatma Education Society's
PILLAI COLLEGE OF ENGINEERING, New Panvel
Department of Mechanical and Automobile Engineering
PROJECT BASED LEARNING (PBL) DEMONSTRATION – RUBRICS & ASSESSMENT SHEET

TOPIC: SHAKER TABLE **YEAR & CLASS:** TE - MECHANICAL (A) **Date of Demonstration:** 27/03/2017

JUDGES: 1. Prof. 2. Prof. 3. Prof. 4. Prof.

Signatures: ________________ ________________ ________________ ________________

REQUIREMENTS: Sine Sweep Excitation of Horizontal Shaker Table, Forcing Frequency (f) = 0-10 Hz, Displacement Amplitude (A) = 0-1 cm, Mass of Shaker Table (excluding the drive unit, & including the stiffeners): the minimum—the better, Direction of movement: any one of X-, Y-, or Z-directions, Shaker Table Dimensions: Square shaped with 15 cm side, Thickness of table: minimum preferred to minimise mass.

STUDENT GROUP –

Name						
Roll No.						
Signature						

1. PERFORMANCE CHARACTERISTICS OF SHAKER TABLE:
   (A) DESIRED VALUES

Set Frequency f (Hz)	2	4	6	8	10
Set Amplitude A (mm)	10	8	6	4	2

   (B) ACTUAL VALUES (through measurements by Accelerometer, DAQ system and LabVIEW software)
   Note: **Print-out of measured Displacement vs. Time plots to be attached in the report.**

Measured Frequency f (Hz)					
Measured Amplitude A (mm)					

2. **Performance Rating:**

   (Pls. tick in the respective box if the desired values are met satisfactorily, by comparison with measured values)

3. **Direction of movement of the Shaker Table:**
   In-plane (X- or Y-) ☐ Transverse/Normal ☐

4. **Whether FEA simulation performed?** Yes ☐ No ☐

   If **Yes** (FEA results to be included to the report, with screenshot images):
   (i) **Number of design options studied:** _______
   (ii) **Fundamental/Lowest Natural Frequency (f_n) of the best option:** ____________**Hz**
   (Note: The greater the fundamental frequency of any design option, the more rigid it is)
   (iii) **Max. Deformation of Shaker Table Plate** (data from the fundamental mode shape) =_______ **mm**

5. **Mass of the Shaker Table (with ribs/stiffeners included)** = ________ **kg**

6. **Thickness of the Shaker Table** = ________ **mm**

7. **Name of the Mechanism/Drive used to achieve sinusoidal motion of Shaker Table:**
   Single Slider Crank mechanism ☐
   Cam and Follower mechanism ☐
   Unbalanced Rotating mass/Eccentric Drive ☐
   Electromagnetic Drive ☐
   Any other (pls specify) ☐ ________________________

8. **Whether the excitation is PC / Smart-phone controlled?**
   Yes ☐ No ☐

9. **Whether the project has any relevance to Mechatronics ☐/☐, Fluid Power ☐/☐, or Metrology ☐/☐ subjects? Yes/No**

10. **Power required to run the unit:** ______ **Watts**

11. **Construction Materials used:** ____________________

12. **Approx. Cost of the project (excluding man-hours):**
    Rs. ______________

13. **Whether Hard Copy of Report submitted?**
    Yes ☐ No ☐

14. **Whether Tabulated Cost Analysis included in the Report?** Yes ☐ No ☐

15. **Is the Shaker Table Unit SAFE to use?** Yes ☐ No ☐

16. **Level of Difficulty of Design:** Good☐ Avg.☐ Poor☐

17. **Build Quality:** (a) Rugged/Weak ☐/☐ (b) Compact/Bulky ☐/☐ (c) Aesthetics (Good/Poor) ☐/☐

18. **Overall Remarks / Rating:** (5-Best, 4-Good, 3-Avg., 2-Poor, 1-V.Poor/To Repeat) ☐

TW Marks Allocation: FEA: /5 MV: /5 MD: /3 Metrology: /2 Mechatronics (for Mech. Only): /2 FP: /2