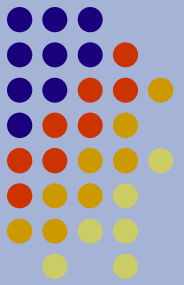
Mechanical & Aeronautical Engineering

Design, built and test experiences within the design curriculum at the University of Pretoria

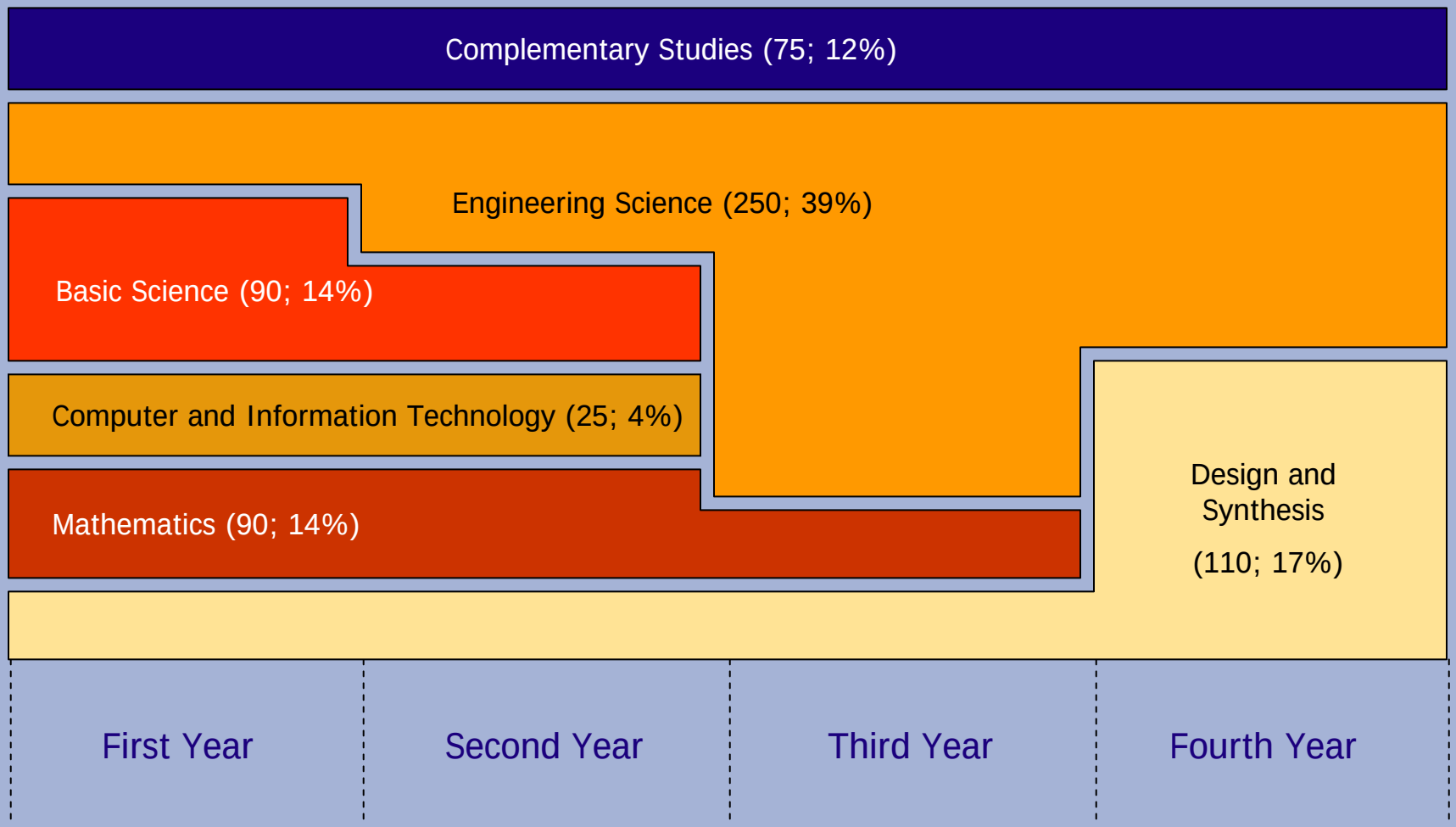
University of Pretoria

MISSION



- The mission of the design group is to teach students mechanical engineering design with an **innovative and practical** approach to ensure that the students is adequately equipped to apply their mechanical engineering **knowledge and skills** in industry

MECHANICAL AND AERONAUTICAL ENGINEERING - UP



DESIGN

Semester 1 (16)

-Engineering drawing
-CAD modeling
-Basic manufacturing

Semester 2 (16)

-Assemblies
-Machine elements
-Basic strength of materials
-Load path diagrams

Mechanics

Innovation

Semester 3 (8)

-Systems engineering
-Design of a system
-Bearings (Plain/rolling)
-Shaft design
-Fatigue

Strength of materials

Material Science

Dynamics

Semester 4 (8)

-Mechanisms
-Drives (V belts /chains)
-Bolted connections (Static/dynamic)
-Welds(Static/dynamic)
-Mechanism project in groups of 2
Concept, design, build, test,
Design review, Compete

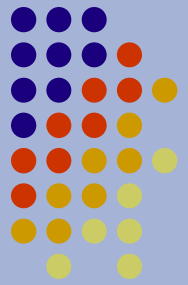
Strength of materials

Dynamics

Theory of machines

All problems are industry related with innovative solutions as a central theme

DESIGN



Semester 5 (16)

-Gear systems and gear design
-Rope systems
-Lubrication
-Pressure vessels
-Springs
-Ergonomics
-Contact stresses

Strength of materials

Theory of machines

Dynamics

Semester 6 (16)

-Product design
- Inception
- Functional analysis
- Industrial design
- Rapid proto-typing
- Intellectual property

-Final evaluation is project in groups of 8, presented to panel of judges

- Structural design and FEM

All problems are industry related with innovative solutions as a central theme

Semester 7 (16)

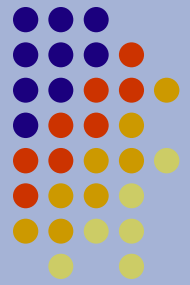
-Final year design(Individual)
-160 hours
-First phase of final year project

Semester 8 (24)

-Final year project (320 hours)
- Design/Research
- Built
- Test

All the fundamental sciences as required

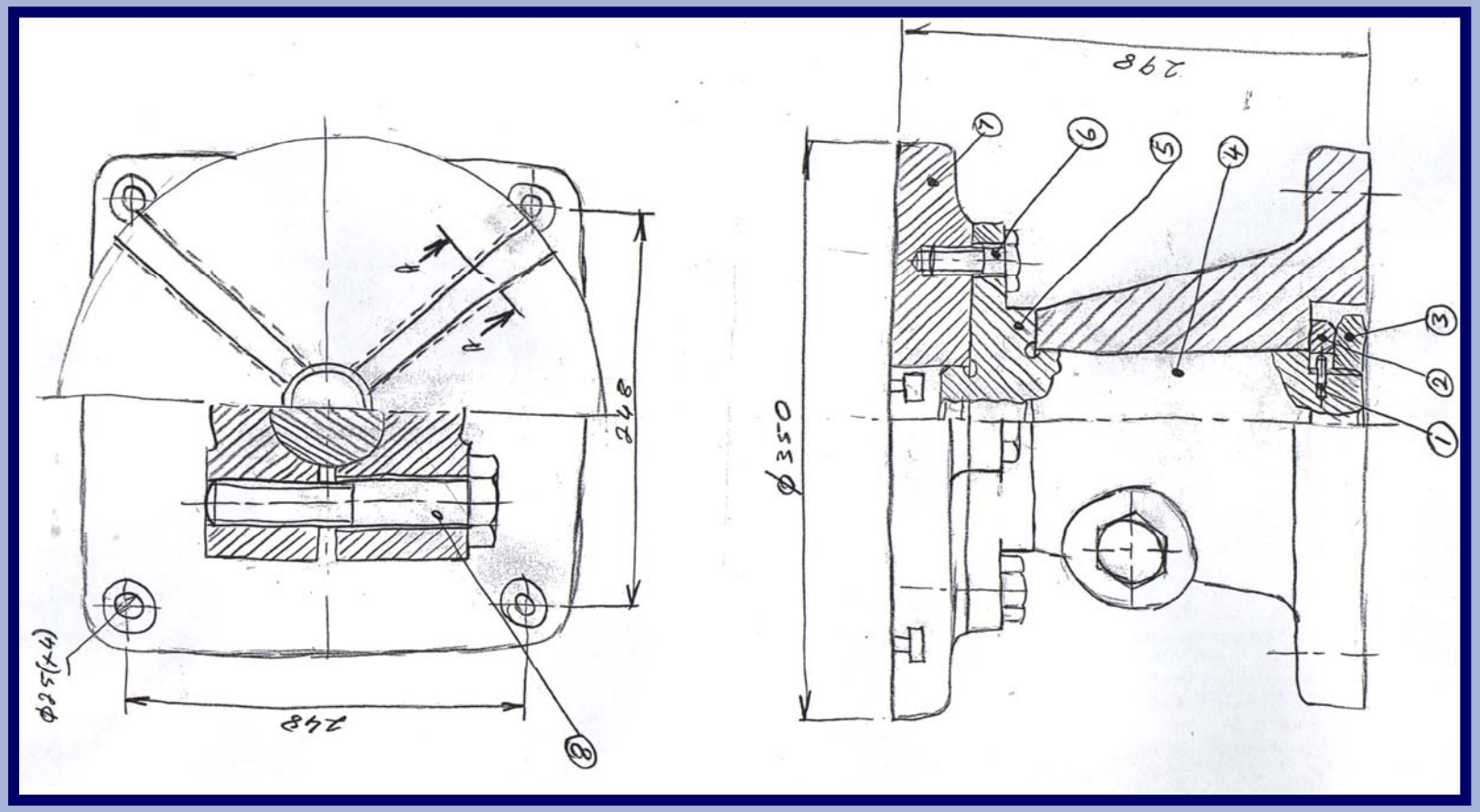
SEMESTER 1 AND 2



- Engineering drawing
  - Free hand sketches to teach graphics as communication medium
  - Drawing principles according to ISO
    - Views, auxiliary views, planes, sections etc.
- Basic machine elements – functioning and application
- Solid modeling – solidWorks
  - Self study with scheduled assignments (no lecturing)
- Basic manufacturing
- Basic strength of materials
  - Tension, compression and shear
- Assemblies – Assemble a selection of components into assemblies
- **Evaluation**
  - **Theory: 30%**
  - **Practical (design): 70%**

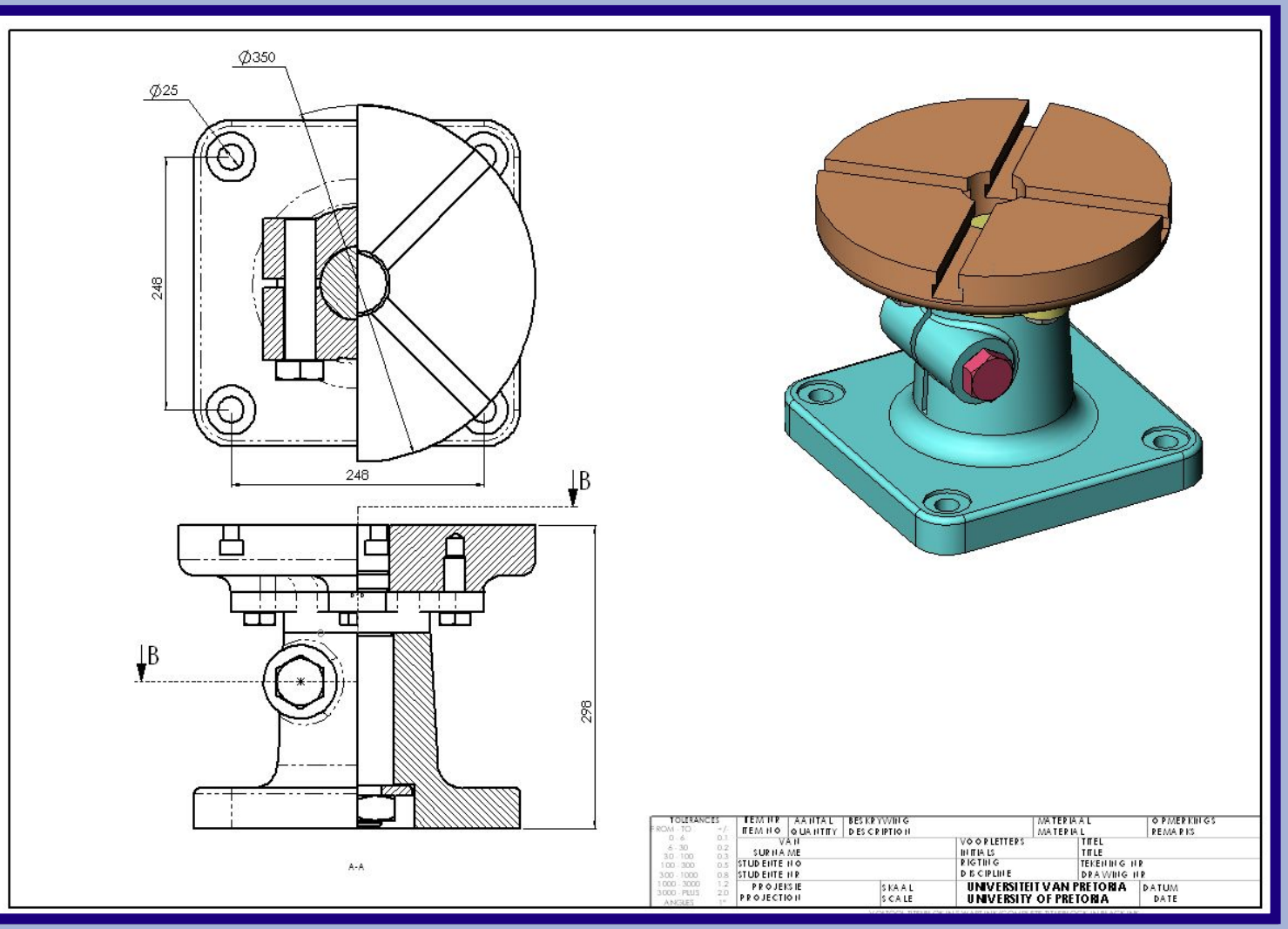
SEMESTER 1 AND 2

Free hand sketch of an assembly – machine table



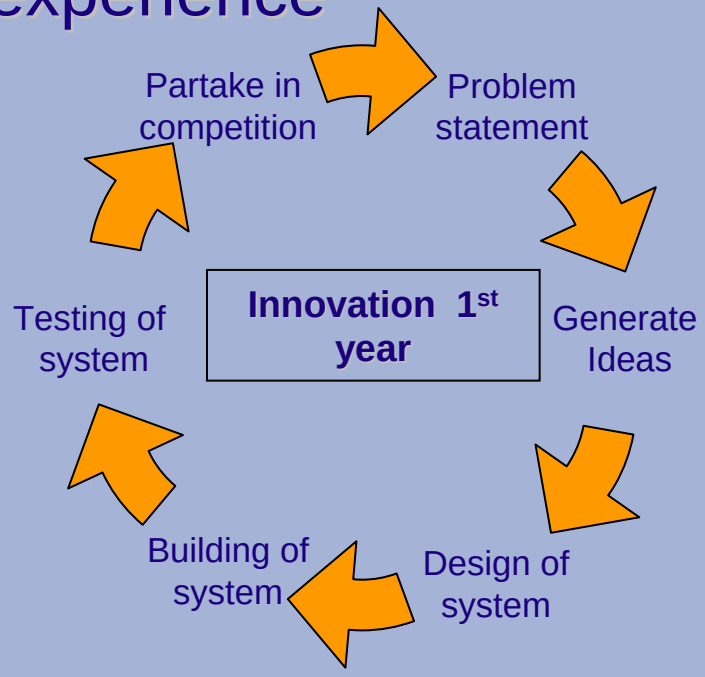
SEMESTER 1 AND 2

Solidworks assignment

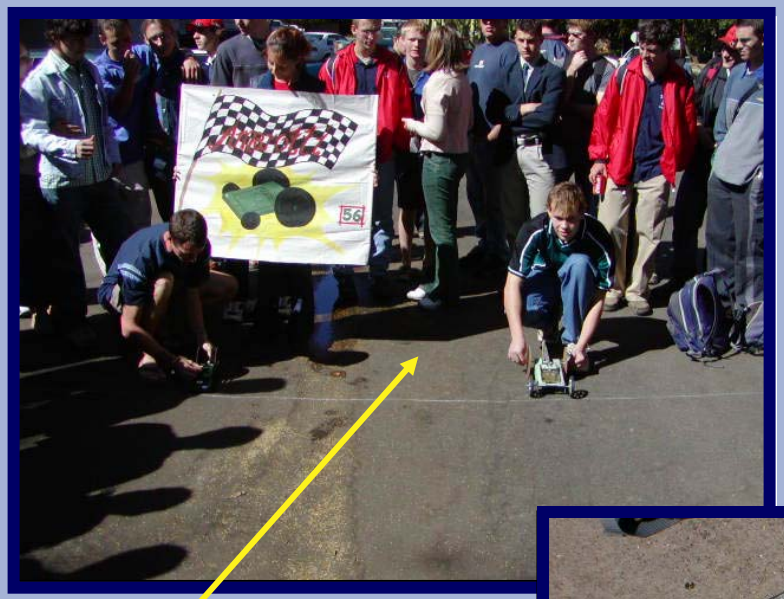


SEMESTER 1 AND 2

- Innovation
  - First year students work in groups of 4
    - Emphasis on innovation
  - First design build and test experience
    - Problem statement
    - Design of a system
    - Building of the system
    - Testing of system
    - Partake in competition

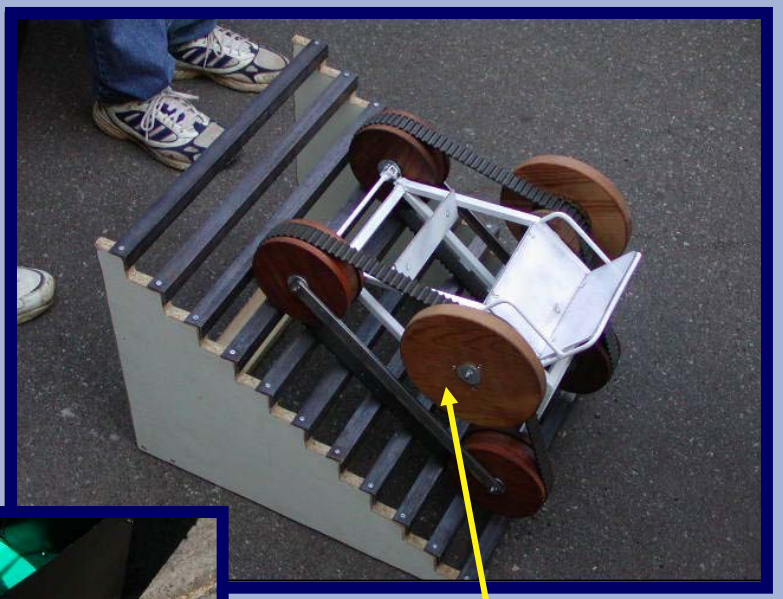


SEMESTER 1 AND 2



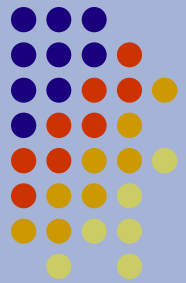
Mouse trap driven race cars

Sun power baking oven



Mouse trap driven stair climber

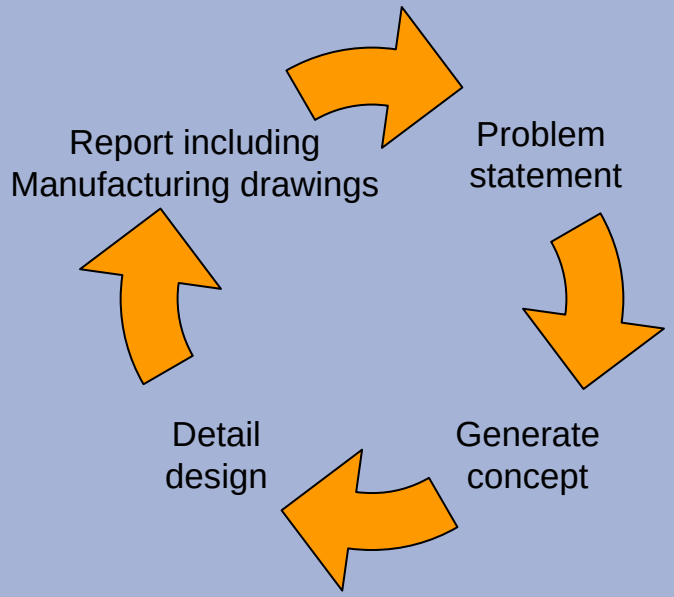
SEMESTER 3 AND 4



- Engineering design
  - Systems engineering – principles and application
  - Bearings
    - Journal and rolling element
  - Shaft calculations
    - Static (Bending and shear force diagrams)
    - Dynamic (Fatigue)
  - Drives
    - V Belts and chains
    - Clutches and brakes
  - Bolted connections
    - Static and dynamic
  - Weld design
    - Static and dynamic
- Mechanisms
  - Design mechanism of mechanical toy i.e. walking dog that can back flip and wag it's tale
  - Mechanism project where students must **design, build and test** own mechanism to partake in competition and complete design review with final written report
- **Evaluation**
  - **Theoretical: 30%**
  - **Practical(design): 70%**
  - **Mechanisms project must be completed and sub minimum of 40% apply**

SEMESTER 3 AND 4

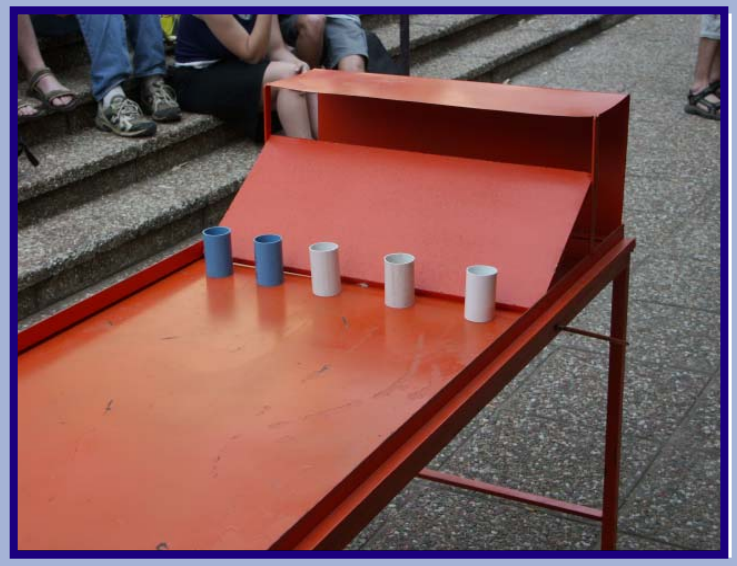
- Semester project for third semester
  - Design abrasive cut-off machine including all calculations for shafts, bearings, drives, etc.
  - Develop solid model of design with detail manufacturing drawings
  - Written report
  - Done in groups of 3
  - 6 weeks
  - Paper exercise



SEMESTER 3 AND 4

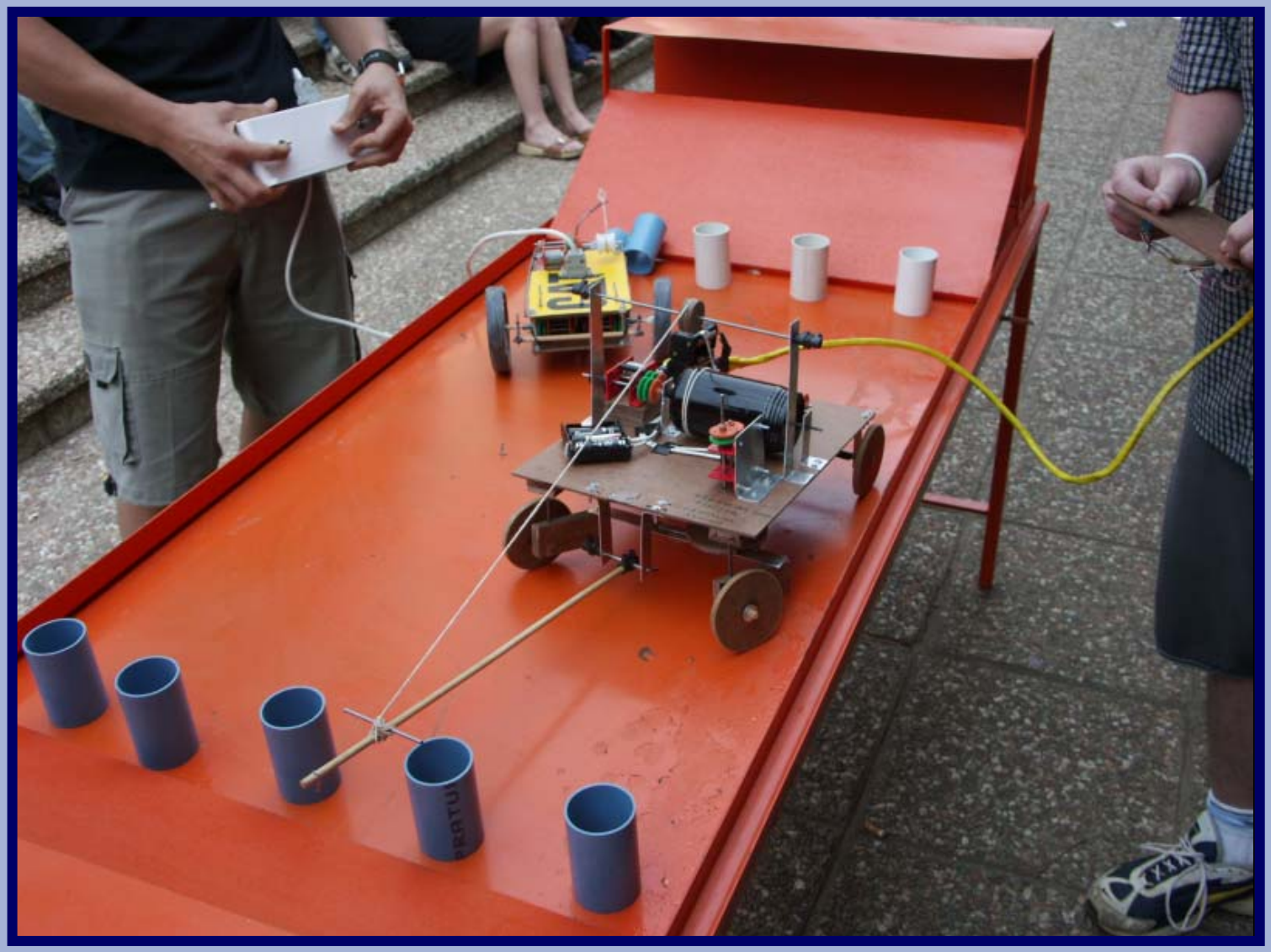
SEMESTER 3 AND 4

- **MECHANISM PROJECT – Semester 4**
  - Design a mechanism for solving a certain problem statement within the limitation of certain set of rules – in groups of 2
  - Material
    - Only material supplied by Department or as specified in list may be used
    - Power source: 3 x 4.5 V motor/gearbox units
  - Students must build their own remote control – must acquire own knowledge how to build control with umbilical chord
  - Student may use Departmental Workshop facilities
  - Mechanisms are evaluated and scrutinized before competition
  - Students partake in competition to determine best mechanism in group
  - Cash prize for winners
  - Project for design, build and test is done in 6 weeks

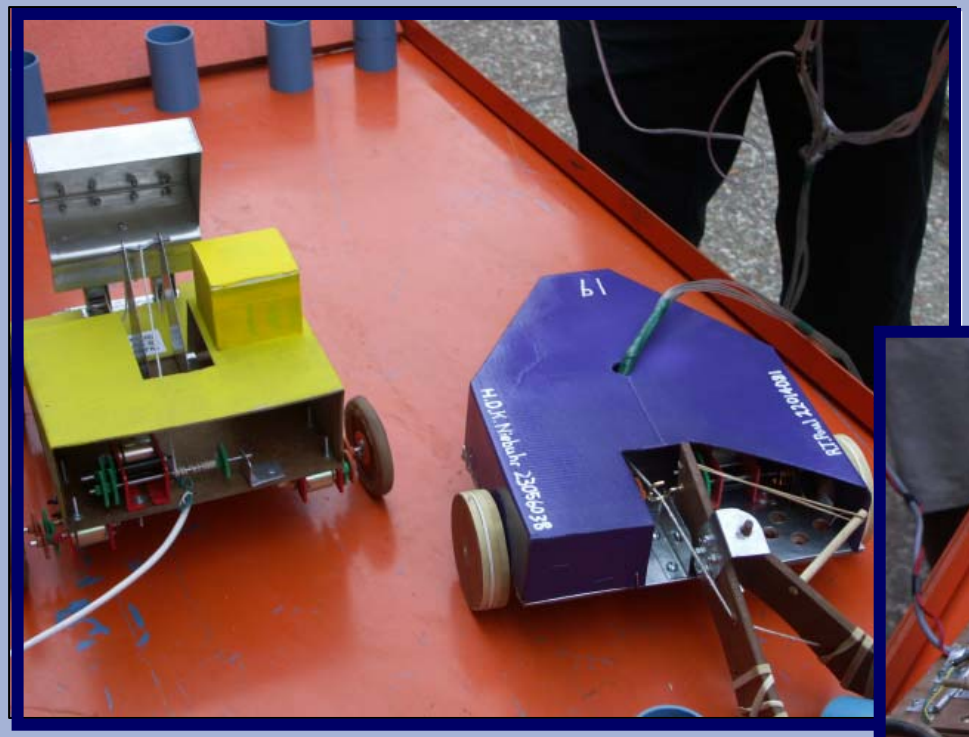


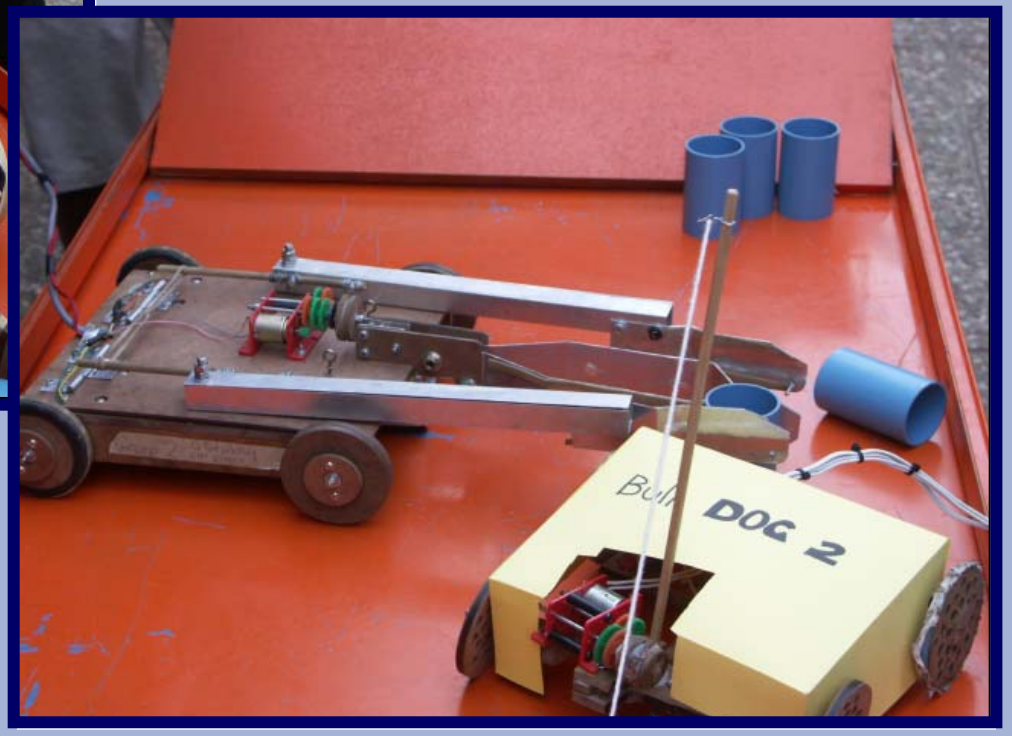
Playing field given to students as 2D drawing

SEMESTER 3 AND 4

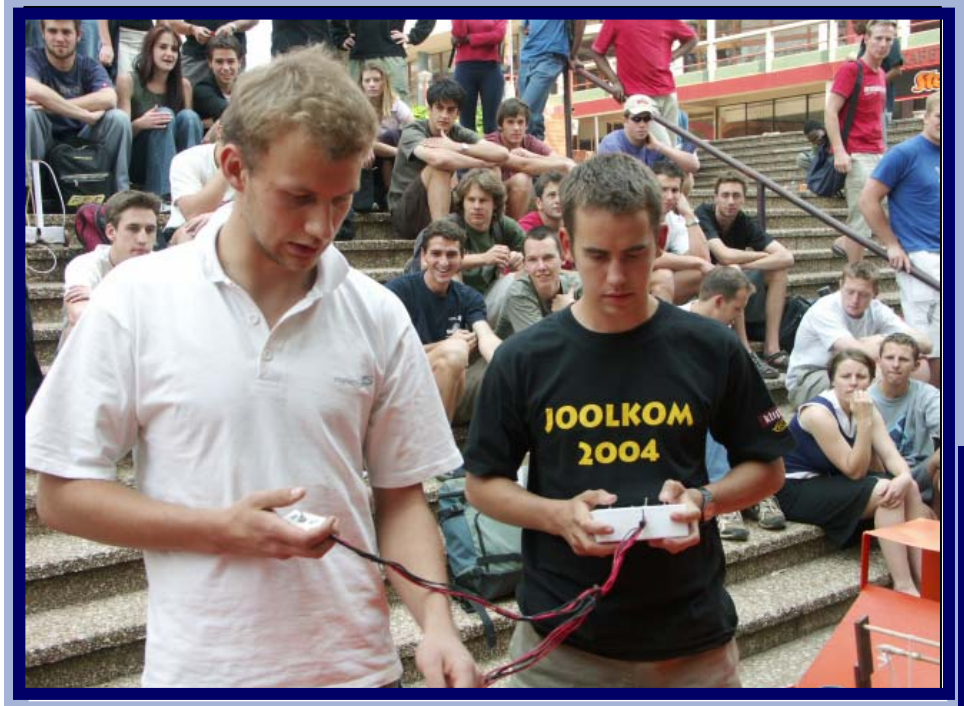


SEMESTER 3 AND 4



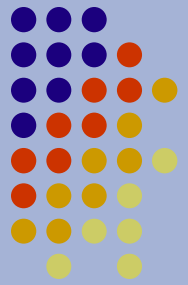


SEMESTER 3 AND 4



Fantastic student participation

SEMESTER 3 AND 4



Written report
Covering project
20%

Problem
statement

Partake in
Competition
Winner get cash prize

Concept design
Per student
10%

Evaluation of as build drawing
for mechanism as presented
10%

Concept design
per group (2)
10%

2nd Mechanism project

Presentation of
Mechanism to judging panel
40%

Concept evaluation

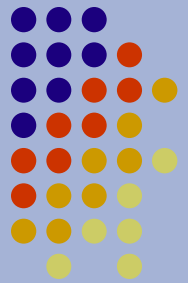
If system can perform
function: 50%

Testing of
mechanism

Detail design
of system
10%

Building of
mechanism

SEMESTER 5

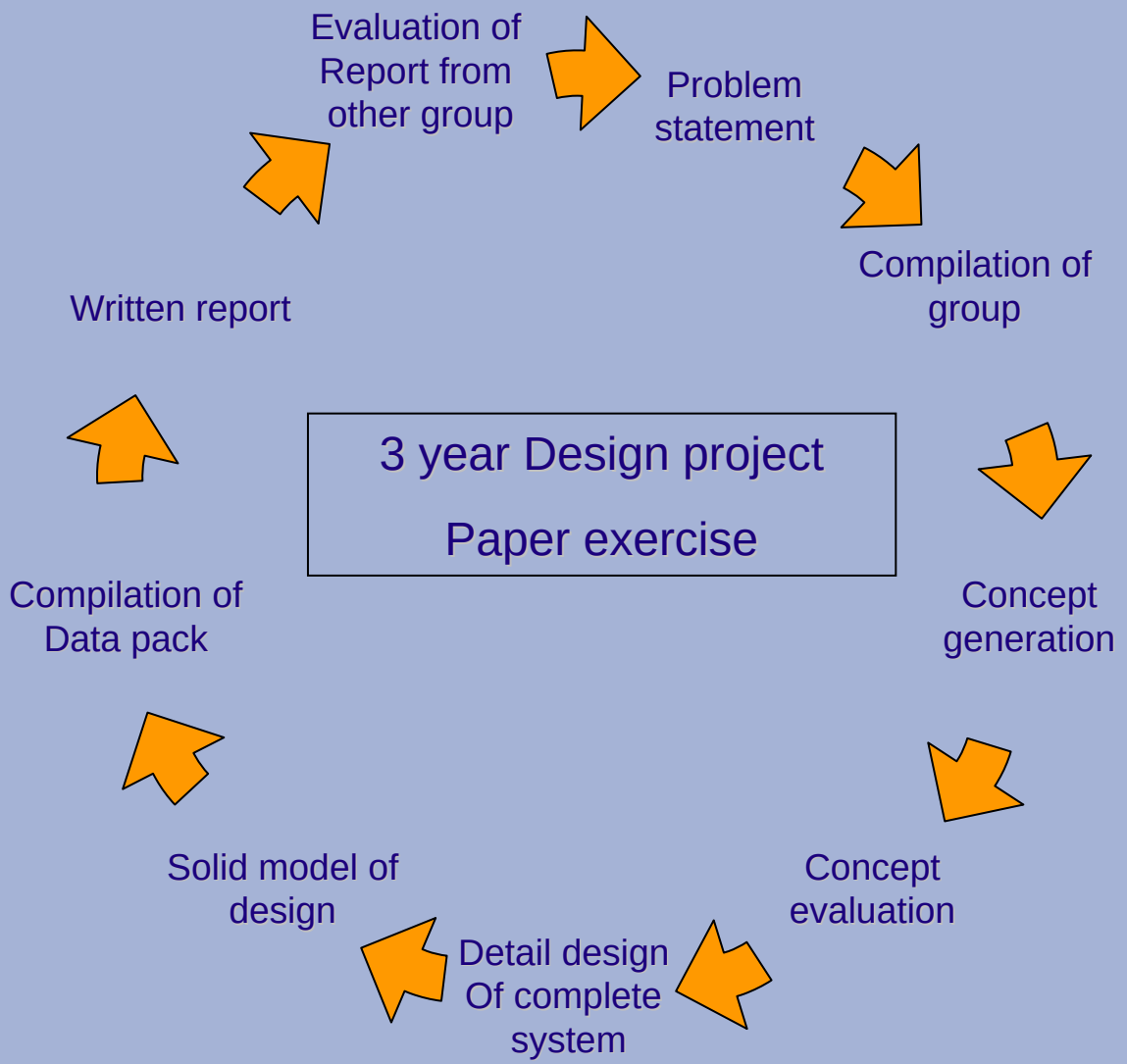


- Ergonomics
  - Assignment: Example - design of a LHD cab
- Contact stresses
- Springs
  - Tension and compression
- Lubrication
  - Hydrodynamic
- Design of gears
  - Gear systems
  - Gear design according to AGMA code
- Steel wire ropes
  - With reference to OHS act
- Pressure vessels
  - With reference to OHS act
- Various guest lectures (Industry)
  - Practical heat treatment
  - Composite materials
  - None destructive testing
- **Evaluation**
  - **Theoretical and design: 100%**
  - **Semester project account for 60% of semester mark**

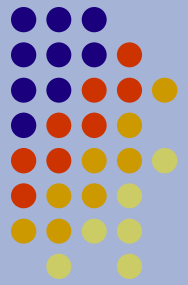
SEMESTER 5

- Typical assignment for semester
  - Assignment done in groups of 5
  - Detail design must include
    - Shafts
    - Bearings
    - Gears
      - Gear train
      - Gear design
      - Contact stresses
    - Brakes
    - Lubrication
    - Complete structure
  - Final deliverable: Written report
  - Evaluation
    - Evaluated by other groups for a mark (according to marking schedule)– 50%
      - This is done to prepare them for their final year design and project
    - Evaluated by lecturers – 50%

SEMESTER 5

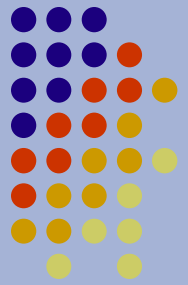

Evaluation of Report from other group
Problem statement
Compilation of group
Concept generation
Concept evaluation
Detail design Of complete system
Solid model of design
Compilation of Data pack
Written report
3 year Design project
Paper exercise

SEMESTER 6



- Product design - including
  - Functional analysis to compile design parameters
  - Concept design and evaluation
  - Life cycle costing
  - Maintenance analysis
  - Manufacturing analysis
  - Product support
  - **Building and testing of prototype**
- Structural design
  - Use of structural code
  - Finite element analysis (Patran/Nastran)
- **Evaluation**
  - **Students are divided into groups of 8 and must develop a product to concept prototype phase. Group is evaluated by a panel of judges from industry. The team members evaluate each other individually to determine final mark.**

SEMESTER 6



3 year product development assignment

Each individual in class must identify a need (product)

Class vote for top x needs (Depends on number of groups)

Each group compile needs Analysis for their selected product

Functional Analysis 5%

Market Survey 5%

Concept design

Detail Design 45%

- Detail design include
  - Life cycle costing
  - Maintenance analysis
  - Manufacturing analysis
  - Product support

Building of Prototype

Testing of prototype

Presenting Prototype to panel of Judges 45%

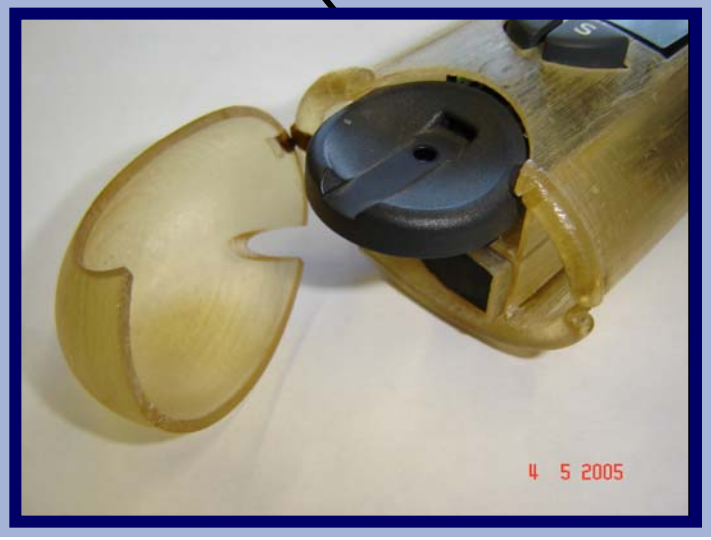
SEMESTER 6

Insulin tester with sterile dosage according to preset value

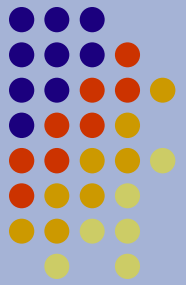
Insulin tester read out

Sterile filling of insulin reservoir

Insulin applicator

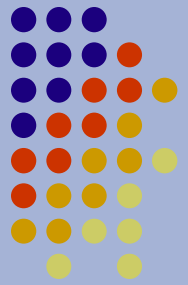


SEMESTER 7



- **Design**
  - Entails any design based on mechanical engineering. It is not restricted to machine design only, but will always contain a substantial component of machine design in the final project
- **Final year design: Scope**
  - To execute a typical design task as it is generally found in practice, professionally and completely in order to satisfy the user requirements and the specification in a safe and economical manner.
  - To be able to prepare the drawings and documents with the necessary clarity so that the equipment can be manufactured without any misunderstanding
  - Apply the knowledge of the subjects that he/she has already studied in a meaningful way in order to solve the problem
  - To acquire the knowledge that he/she does not possess as yet, but which is needed for the execution of the project on his own

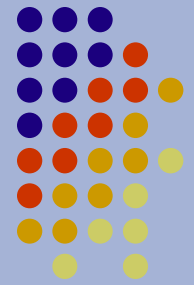
SEMESTER 7



- **Evaluation**
  - **Evaluation of design by internal and external examiner**
  - **Evaluation of drawings by draughtsman**
  - **Presentation with oral exam**
  - **Adjudication of marks**
    a. **Engineering problem solving: 20%**
    b. **Application of fundamental and specialist knowledge: 23%**
    c. **Engineering design and synthesis: 27%**
    d. **Professional and general communication: 30%**

    Sub minimum of 50% apply to quality of report and drawings

SEMESTER 7



Evaluated by internal and external examiner

Critical outcome

Oral presentation

Report

User requirement

Problem definition

System specification

Literature study

Concept design

Detail design And analysis

Manufacturing analysis

Cost analysis

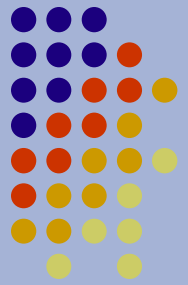
Assembly and Detail drawings

Evaluated by draughtsman.

Critical outcome

4th year Design

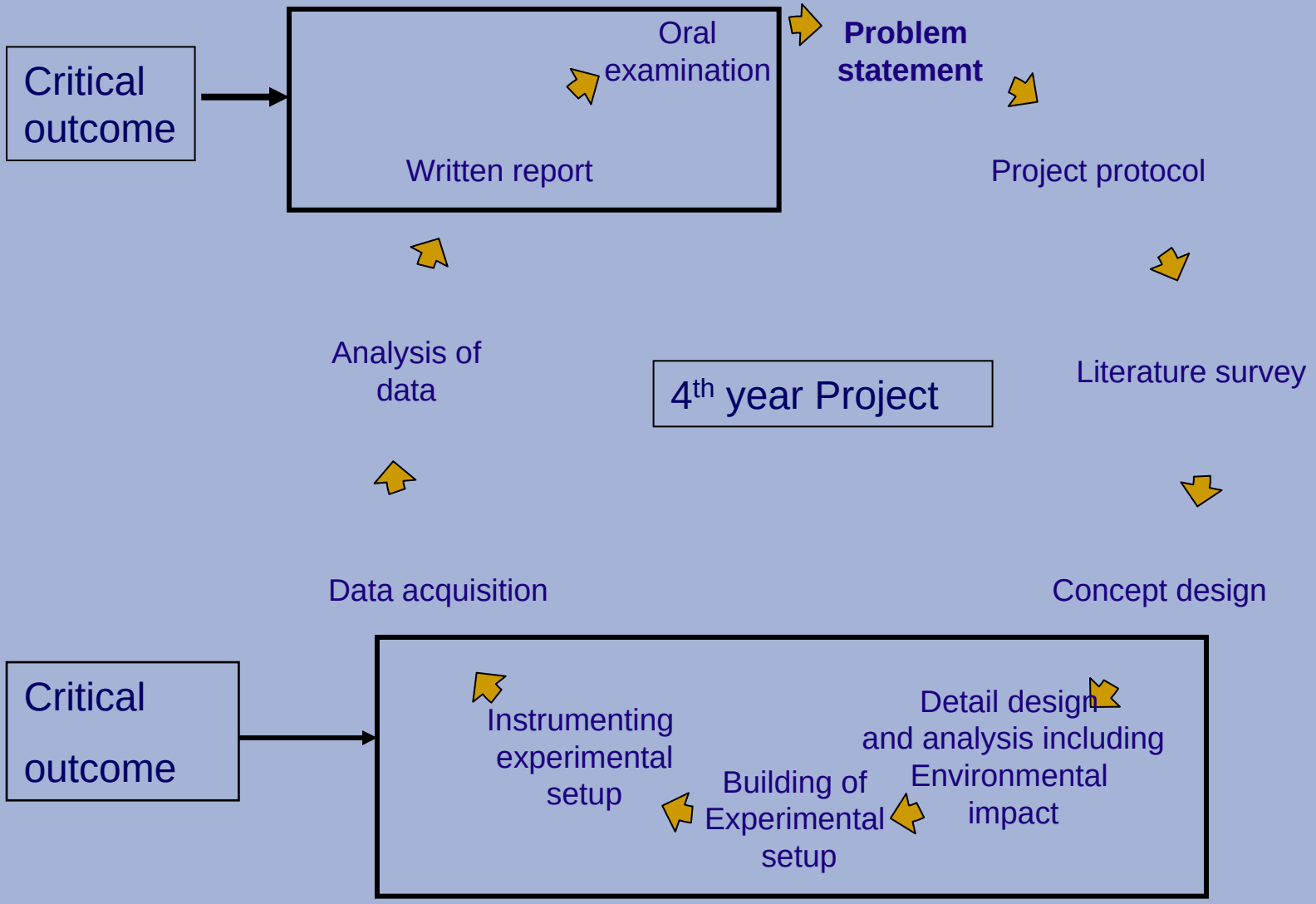
SEMESTER 8



- **Final year project: Goal**
  - To execute an engineering project as typically experienced in practice, on his/her own: and to professionally execute an investigation within a pre-defined budget and time limit
  - The student should be able to apply all the knowledge acquired thus far at university in order to solve the problem that is presented to him/her
  - To acquire by his/her own effort and initiative, new theoretical or empirical knowledge required to master the task
- **Evaluation**
  - **Evaluation of project by internal and external examiner**
  - **Presentation and oral exam**
  - **Graphic presentation (poster) of work at end of year function**
  - **Adjudication of marks**
    a. **Engineering problem solving: 13%**
    b. **Application of fundamental and specialist engineering knowledge: 23%**
    c. **Engineering design and synthesis: 20%**
    d. **Investigations, experiments and data analysis: 17%**
    e. **Engineering methods, skills, tools and information technology: 3%**
    f. **Professional and general communication: 24%**

    Sub minimum of 50% apply to both d and f

SEMESTER 8


Critical outcome
Oral examination
Written report
Problem statement
Project protocol
Literature survey
Concept design
Detail design and analysis including Environmental impact
Building of Experimental setup
Instrumenting experimental setup
Data acquisition
Analysis of data
4th year Project
Critical outcome

FINAL YEAR PROJECTS

Mini Baja

The proud final year students pose with their homemade gliders

FINAL YEAR PROJECTS

Exulans - glider

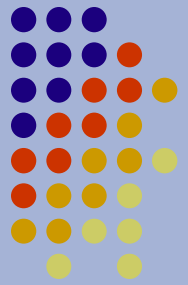
10th Scale mine headgear for overwind/underwind simulations

FINAL YEAR PROJECTS

Single station mechanical hip simulator according to Paul profile

Columbus water model

STUDENT INVOLVEMENT WITH INDUSTRY PROJECTS



• A number of initiatives to get students involved in industry related projects are in progress. The major initiatives are

- •Mining Industry
- •Pebble bed nuclear reactor
- •Vehicle engineering

Industry	Final year design	Final year project
Mine related projects (DME, Mine houses)	18 students	21 students
PBMR	8 students	12 students
Vehicle Engineering (John Deere, Cummins, Caterpillar)	13 students	14 students