MOX410 - Design Project (2015)

Project List

02 December 2014

Dr A Lexmond

Desalination

Lecturer, Dr A Lexmond
Max students, 3

Project Description

Background:
Several regions in the world have very limited access to fresh water. To overcome the fresh water shortage, sea water can be desalinated to produce fresh water. There are basically 2 desalination techniques: one is thermal desalination, where free energy is added in the form of a heat flux over a temperature gradient (requiring heat). The other technique uses membranes, where free energy is added as a pressure difference (requiring power).
Desalination cannot only be used for sea water purification, but also for demineralization or purification of high mineral content water from aquifers or polluted streams.
This makes desalination a relevant technique for combatting South Africa's water shortage issues. Since coal is readily available at a low cost and electricity shortages are expected to rise over the coming years, a thermal desalination method is likely to be the most successful in this country.
Thermal desalination is achieved by evaporating salt water and condensing the vapour to form fresh water. The efficiency is increased by thorough thermal integration of the process. However, since the heat of evaporation of water is very high, total energy consumption is significant.
At elevated temperature and pressure, evaporation of water requires significantly less energy due to a reduced heat of evaporation. This effect is especially large close to the critical point. (374°C).. Thus, thermal desalination at temperatures above 350°C will significantly reduce energy consumption.
A preliminary study has shown that not only the energy consumption, but also the exergy destruction decreases as desalination is performed at near-critical conditions. Theoretically, a decrease in exergy production with as much as 80% should be feasible.

Problem statement:
However, high-temperature desalination comes at a significant cost. First of all, the solubility of water for many salts decreases, which can result in increased fouling. On top of this, the water vapour also becomes a solvent for most salts. As a result of this, purification performance drops as the temperature goes up. Thirdly, the surface tension of water disappears at the critical point, which will result in excessive foaming when boiling or evaporation takes place. This will make the phase separation harder, which will already be more difficult than phase separation at ambient conditions due to the decreased density difference between the phases.
Other issues which will have to be solved are the increased corrosiveness and pressure, which will result in more costly equipment.
Thus the design problem covers several engineering disciplines which a mechanical engineer should master; heat and mass transfer for microscale performance optimization, material selection for corrosion mitigation and mechanical design to ensure safe operation at elevated temperature and pressure.

Objective:
The critical step for the overall performance, and also the most difficult to design is the highest temperature stage: the evaporation, phase change and condensation in the boiler. The students are expected to design this stage.
The main focus will be on the internal geometry of the boiler to prevent phase mixture formation (foam, emulsion, mist…) and to ensure proper phase separation.
The students are allowed to base their process design on a Multiple Effect Desalinator. (MED)
The objective is to design the last few desalination effects which operate at sub-critical conditions at which the discussed phenomena occurs and to solve the fluid mechanics problems associated with it.
The students will have to deliver a design for a 100 l/h (student 1) and a 10m³/h (student 2) high temperature desalinator.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Experimental hopper design

Lecturer, Dr A Lexmond
Max students, 3

Project Description

Background
Hoppers are process units, used for storage and dosing of granular solids. Usually hoppers are vertically placed cylindrical vessels with a conical bottom. Different solids mixtures (powders) show different flow behaviour. As a result, the hopper design has to be adjusted to match the flow characteristics of the powder. A common way to change the outflow is by adjusting the shape of the conical bottom of the hopper, as well as adjusting the size of the outflow hole.
Problem description
For performing experiments with coal, a 50l hopper which matches the flow characteristics of various coal powders and granular mixtures is needed. Since the type of coal will be varying all the time, a hopper with variable cone angle and variable outflow opening is needed.

Objective
A (near-) cylindrical 50 l hopper with a variable cone angle and variable outflow hole diameter has to be designed. It should be possible to vary the cone angle between 40° and 90°; The outflow hole should be variable between 1cm and 5cm. It is an added advantage but not a requirement when you come up with a design in which the hopper shape can be adjusted while the hopper is full. Additional requirements (in order of relevance) are:
Safe to use
Reliable and robust
Cost effective
Easy to adjust

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Energy recovery in Vanadium ore cooling

Lecturer, Dr A Lexmond
Max students, 4

Project Description

Background
Vanadium ore is purified by converting it into sodium vanadate in a furnace; operating temperature in the furnace is well above 1000°C. The ore leaves the furnace as a sticky solid/liquid mixture. Currently, this mixture is dumped in a water bath, where the sodium vanadate dissolves and the heat is dissipated by evaporation of significant amounts of water. There is some evidence that the very fast cooling of the sodium vanadate in water causes undesired side-reactions, which decrease the process efficiency considerably. On top of this, this process uses considerable amounts of energy and water.
Problem/opportunity description.
To increase the process yield, a method is needed to slowly cool down the sodium vanadate. Typical targeted cooling rates are from 1200°C to about 100°C in 2 minutes. Since the vanadate is produced continuously, a continuous cooling mechanism is needed. Slow and continuous heat transfer is ideal for thermal integration. The thermal energy of the sodium vanadate can be used for various purposes. Two possible applications are to use the heat for heating up the ore which is being fed into the furnace. This could reduce both the energy and water consumption of the process by about 80%. Alternatively, the heat can be transferred to a power cycle, creating electricity.

Objective 1 (2 students)
Design a continuous cooler to cool the sodium vanadate leaving the furnace down to about 100°C. Design the cooler in such a way that the heat is transferred to the ore which is being fed to the furnace. You will have to proof the predicted heat transfer using numerical simulations (preferred) or heat transfer calculations. Use your heat transfer calculations to estimate the reduction in process irreversibility. The focus of your work will be on design and scaling of the heat transfer equipment. Determining the proper size, materials and estimated cost are key factors in the design.

Objective 2 (2 other students)
Design a continuous cooler to cool the sodium vanadate leaving the furnace down to about 100°C. The heat must be transferred to a power cycle. You can choose the power cycle you like; (amongst others) Rankine-type cycles, Brayton-type cycles and Sterling cycles are in scope. Estimate the work production of the power cycle. The focus of your work will be on design and scaling of the heat transfer equipment. Determining the proper size, materials and estimated cost are key factors in the design.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of solar cell cooling panels

Lecturer, Dr A Lexmond
Max students, 4

Project Description

Background
Solar intensity in South Africa is amongst the highest in the world: twice as high as in southern Europe, and almost 3 times higher than northern Europe. On top of this, cost of electricity increases and reliability of electricity distribution decreases. For these reasons, off grid/ grid independent energy production makes a lot of sense in South Africa. This assignment focuses on the use of photovoltaic (PV) panels, which generate electricity.

Problem description
The efficiency of PV solar panels depends not only on the solar irradiation intensity, but also on the temperature of the panel. As the panel temperature increases, the output voltage of the panel drops. Without cooling, panels can reach temperatures of around 100°C, where the output voltage has dropped by about 60%, compared to the output at 25°C. As a result, far less energy is produced by the hot panel. The most logical way to solve this is by cooling the solar panels.
Objective
I want the students to design a solar panel frame with an integrated air cooling mechanism. Both the application and the cooling mechanism have impact on the design. There are 2 application of relevance: solar panels for domestic use and solar panels for large scale grid-independent use. As a case example of the domestic application, I want you to focus on a solar panel for RDP housing. As an example of a large scale grid-independent case, the student has to consider a solar farm for a farmer in the Karoo. Students can consider both free convective and forced convective designs. In a free convective design, heat transfer from wind (if any) and draft from reduced density of the hot air at the panel surface can be enhanced using for example fins at the back of the panel. For the forced convective design, a fan can be used to create a forced convection, which enhances the heat transfer.
Combining the two applications and the two cooling mechanisms, 4 students can be staffed on this assignments:
1 For large scale application, free convective cooling (no pumps, fans, etc)
2 For large scale application, forced convective cooling (using pumps, fans, etc)
3 For domestic application, free convective cooling (no pumps, fans, etc)
4 For domestic application, forced convective cooling (using pumps, fans, etc)
The student is expected to design a frame to hold a 1m² solar panel. Both the frame and the cooler should be virtually maintenance-free. A very important design criteria is that the frame should be designed in such a way that it can be constructed by employees with very little technical training.
Using dimensionless correlations or (preferably) numerical simulations, the students should be able to estimate how big the reduction in temperature of the solar panel is for his design. This correlates to an added power generation, which has a distinct value. As an example, reduction of the temperature of a solar panel from 100°C to 25 °C increases the PV panel output by 150%. Since a PV panel costs about 2000 Rand, this temperature decrease is worth about 3000 rand per panel.
The student is expected to show that the added cost of the panel cooler is offset by the increased productivity of the panel.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

High temperature Desalination

Lecturer, Dr A Lexmond
Max students, 2

Project Description

Background
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Desalination cannot only be used for sea water purification, but also for demineralization or purification of high mineral content water from aquifers or polluted streams.
This makes desalination a relevant technique for combatting South Africa's water shortage issues. Since coal is readily available at a low cost and electricity shortages are expected to rise over the coming years, a thermal desalination method is likely to be the most successful in this country.
Thermal desalination is achieved by evaporating salt water and condensing the vapour to form fresh water. The efficiency is increased by thorough thermal integration of the process. However, since the heat of evaporation of water is very high, total energy consumption is significant.
At elevated temperature and pressure, evaporation of water requires significantly less energy due to a reduced heat of evaporation. This effect is especially large close to the critical point. (374°C).. Thus, thermal desalination at temperatures above 350°C will significantly reduce energy consumption.
A preliminary study has shown that not only the energy consumption, but also the exergy destruction decreases as desalination is performed at near-critical conditions. Theoretically, a decrease in exergy production with as much as 80% should be feasible.
Problem statement
However, high-temperature desalination comes at a significant cost. First of all, the solubility of water for many salts decreases, which can result in increased fouling. On top of this, the water vapour also becomes a solvent for most salts. As a result of this, purification performance drops as the temperature goes up. Thirdly, the surface tension of water disappears at the critical point, which will result in excessive foaming when boiling or evaporation takes place. This will make the phase separation harder, which will already be more difficult than phase separation at ambient conditions due to the decreased density difference between the phases.
Other issues which will have to be solved are the increased corrosiveness and pressure, which will result in more costly equipment.
Thus the design problem covers several engineering disciplines which a mechanical engineer should master; heat and mass transfer for microscale performance optimization, material selection for corrosion mitigation and mechanical design to ensure safe operation at elevated temperature and pressure.
Objective
The critical step for the overall performance, and also the most difficult to design is the highest temperature stage: the evaporation, phase change and condensation in the boiler. The students are expected to design this stage.
The main focus will be on the internal geometry of the boiler to prevent phase mixture formation (foam, emulsion, mist…) and to ensure proper phase separation.
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Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Dr L Martins

Design of a generator for an absorption system for domestic applications

Lecturer, Dr L Martins
Max students, 3

Project Description

1. Background

Since the highest demand of cooling systems corresponds to the period of high availability of solar energy, air conditioning emerges as another promising application for solar energy. Absorption systems are alternatives for the combination air-conditioning and solar energy.

2. Problem statement

The design of a generator for an absorption system for air-conditioning.

3. Objectives of the design

The purpose of this study is to design the generator for a absorption system.

4. Drawing

Drawing should be detailed an should include the layout of the cooling system.

5. User/Client specifications

The aim of this project is to design a generator of a domestic air-conditioning unit.

6.Outcomes

A drawing of the system including all the components and their sizes. A detailed analysis to determine the most effective type of the generator. Specifics of the material and manufacturing methods.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a solar concentrator and a energy storage system for refrigeraton applications

Lecturer, Dr L Martins
Max students, 4

Project Description

1. Background

Solar concentrators are devices used to direct the sun radiation to one specific spot generating heat. Energy storage systems are very important in power systems as a way of supplying energy when the primary source of energy is not available. For example, when due to weather conditions, solar radiation is reduced; energy storage systems can minimize the effect of such reduction.

2.Problem statement

The design of a solar concentrator and an energy storage system that can be used in a solar power plant to minimize effects of reduction of solar radiation.

3.Objectives of the design

The objective of this study is to design the solar concentrator and the energy storage system for a heat driven system.

4.Drawing

Drawing should be detailed and should include the layout of the simplified system.

5.User/Client specifications

The aim of this project is to design a solar concentrator capable to provide energy necessary to run a domestic refrigerator.

6.Outcomes

A drawing of the system including all the components and their sizes. A detailed analysis to determine the most effective type of the concentrator and storage energy

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a solar system for domestic applications

Lecturer, Dr L Martins
Max students, 3

Project Description

1. Background

More and more emphasis has been put in using solar energy for water heating for houses and buildings, becoming even mandatory in some countries. Most of the electricity spent in a household is used for water heating; which would be reduced significantly if solar energy is used. The demand of hot water may not coincide with the highest availability of solar energy, so a system for energy storage is required.

2.Problem statement

To design a solar collector and energy storage system for water heating in domestic applications.

3.Objectives of the design

The objective of this project is to design a solar collector and energy storage system that will be used to supply hot water for domestic applications, considering demands of hot water and availability of sun energy.

4.Drawing

Drawing should be detailed and should include the layout of the simplified system.

5.User/Client specifications

6.Outcomes

A drawing of the system including all the components and their sizes. A detailed analysis to determine the most effective type of the concentrator. Specifics of the material and manufacturing methods.
A drawing of the system including all the components and their sizes. Specifics of the material and manufacturing methods.

2. Problem statement
3. Objectives of the design
4. Drawings
5. User/client specifications
6. Outcomes

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Ms B Huyssen

Single strut system for CSIR’s LSWT

Lecturer, Ms B Huyssen
Max students, 2

Project Description

1. Background
The CSIR’s Low Speed Wind Tunnel uses an overhead virtual centre balance as its primary aerodynamic force measurement instrument. Wind tunnel models are attached to the balance via a central strut with the addition of a pitch cable upstream or downstream of the strut to provide the pitching motion. This cable introduces aerodynamic interference to the flow over the airframe and contributes to the forces measured by the overhead balance. These spurious forces need to be “tared” out to get the net aerodynamic forces acting on the airframe.
2. Problem statement
Design a central strut system that includes a model pitching mechanism so that the additional pitching cable can be eliminated from the support setup.
3. Objectives of the design
To design a pitch strut supporting mechanism for the CSIR’s LSWT, including the motion control mechanisms and strategy. The design shall include a study into similar mechanisms in other tunnels.
4. Drawings
3-D solid model drawings and manufacturing recommendations for the rig, with load case deflection simulations. Specifications of the motion motor(s) and drive mechanisms.
5. User/client specifications
The design has to provide the following:
• Literature survey of similar systems in other tunnels.
• Solution concepts and their development with selection criteria.
• Selection of optimum design.
• Design justifications.

6. Outcomes
• Study of techniques and equipment used
• Concept design and 3-d solid models of the chosen solution
• Design justification of the chosen solution.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

Peter Skinner

External Leader Location

CSIR

External Organisation

CSIR

3-D laser alignment system for the CSIR’s HSWT test section

Lecturer, Ms B Huyssen
Max students, 2

Project Description

1. Background
The CSIR’s High Speed Wind Tunnel (HSWT) performs wind tunnel tests on airframes supported on sting system that provides the pitching and rolling motion. Key to measuring accurate aerodynamic loads on an airframe in the tunnel is the initial alignment of the wind tunnel model. This has to be performed while the model is mounted on the sting support in the test section. The HSWT test section has cross section of 450mmX450mm, and when it is open has an access length that can vary from 750mm to 1200mm. This access is general used to perform alignment measurements in the current setup.
2. Problem statement
To provide a design for 3-D laser alignment system that can be mounted solidly to the tunnel during the setup phase to provide alignment for:
• The wind tunnel model longitudinal axis (roll axis) in the pitch plane
• The wind tunnel model longitudinal axis (roll axis) in the yaw plane
• The wind tunnel model lateral axis (pitch axis) in the yaw plane.
The system must be removed before the testing is performed.
The system itself must provide for its own alignment with respect to gravitational vertical an horizontal planes.

3. Objectives of the design
To design a 3-D laser alignment system for wind tunnel model alignment in the tunnel’s test section during the setup phase of the tests. The system needs to be assembled and remove form the fixed tunnel structure.
4. Drawings
3-D solid model drawings and manufacturing recommendations for the system, with load and deflection calculations. Specifications of the required laser systems.
5. User/client specifications
The design has to provide the following:
• Literature survey of similar systems in other tunnels.
• Solution concepts and their development with selection criteria.
• Selection of optimum design.
• Design justifications.

6. Outcomes
• Study of techniques and equipment used
• Concept design and 3-d solid models of the chosen solution
• Design justification of the chosen solution.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

Naidoo

External Leader Location

CSIR

External Organisation

CSIR

Laser sheet traverse mechanism for CSIRs MSWT

Lecturer, Ms B Huyssen
Max students, 2

Project Description

1. Background
The CSIR's Medium Speed Wind Tunnel (MSWT) notoriously has a difficult view test volume. A common requirement by its clients is to view flow structures around the airframe being tested. This can be achieved by projecting a laser sheet traversal to the test section and being able to transverse it along the longitudinal axis of the wind tunnel. Previous systems used in the MSWT have been dogged by misalignment problems due to vibrations that affected the reflection optics. The MSWT has now purchased an optic fibre to carry the laser light, and requires the design of a steady traversing mechanism to translate the laser sheet.
2. Problem statement
To design a traversing mechanism including the optics necessary to project a laser sheet across the MSWT test section and translate it along the test section longitudinal axis.
3. Objectives of the design
The objective of the design is to take the laser light form the laser system positioned outside the plenum chamber roof, through the plenum wall so that it can project a laser sheet traversal to the test section and translate the sheet along the test section longitudinal axis via a traversing mechanism inside the tunnel between the test section and the plenum roof.
4. Drawings
3-D solid model drawings and manufacturing recommendations for the system, with load and deflection calculations. Specifications of the required optic systems and motion control.
5. User/client specifications

The design has to provide the following:
• Literature survey of similar systems in other tunnels.
• Solution concepts and their development with selection criteria.
• Selection of optimum design.
• Design justifications.
6. Outcomes
• Study of techniques and equipment used
• Concept design and 3-d solid models of the chosen solution
• Design justification of the chosen solution.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

Tim King

External Leader Location

CSIR

External Organisation

CSIR

Design of a steam powered rocket.

Lecturer, Ms B Huyssen
Max students, 2

Project Description

1. Background
Traditionally water rockets use the energy stored in compressed air to propel water through a nozzle creating thrust. Water will boil at a higher temperature when placed under a greater pressure. This phenomenon can be used to store hot water in a tank that, when accelerated through a nozzle, turns to steam due to the drop in pressure.
2. Problem statement
If the nozzle is carefully designed, in addition to the usual energy stored in the compressed air (or possibly water vapor in this case), the energy stored in the water in the form of heat can be exploited to propel the rocket.
3. Objectives of the design
This project involves the design of the rocket engine and all engine systems and auxiliary systems such that the rocket may be successfully integrated into an airframe and launched.
4. Drawings
Manufacturing drawings must be produced for all components.
5. User/client specifications
They will be define by the client
6. Outcomes
Manufacturing drawing of the rocket engine

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

Tim King

External Leader Location

CSIR

External Organisation

CSIR

Design of a Movable Rake to Determine Vortex Core Positions

Lecturer, Ms B Huyssen
Max students, 2

Project Description

1.Background

The influence of vortices in the aerodynamic analysis of slender bodies requires a thorough understanding of vortex shedding. While computational simulations may provide an estimation of vortex core positions and strength, the nature of vortices are more accurately represented in experimental analyses. One method of determining the vortex core positions experimentally is by measuring the pitot pressure in the crossflow plane with the use of a rake.

2. Problem statement
This design project requires the design of a rake which may be placed at certain stations along a wind tunnel model while being able to rotate about the body x-axis to gain a more accurate pressure distribution in the crossflow plane.

3. Objectives of the design
To design a Movable Rake to Determine Vortex Core Positions for the CSIR's LSWT, including the motion control mechanisms and strategy.

4. Drawings
3-D solid model drawings and manufacturing recommendations .

5. User/client specifications
The student will be required to provide:
• Literature survey
• Design requirements
• Concept development (considering available equipment)
• Optimum design (including selection criteria)
• Design justifications
• Manufacturing budget

6. Outcomes
• Concept design and 3-d solid models of the chosen solution
• Design justification of the chosen solution.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

Janine Versteegh

External Leader Location

CISR

External Organisation

CSIR

Design of Simulator force-feel system

Lecturer, Ms B Huyssen
Max students, 2

Project Description

1. Background
Aerosud is developing an Siai Marchetti SF260 training simulator, it will have a fully functional cockpit and visuals system, and needs to have representative handling qualities of the real aircraft, which will require the introduction of a force-feel control system.

2. Problem statement
To be able to fly a representative simulator requires control forces to be accurately modelled to represent the aerodynamics and handling qualities of the aircraft

3. Objectives of the design
To design a Simulator Force Feel Unit for all controls. Involves Aerodynamic Assessment of an SF260 aircraft, Determination of Longitudinal Stability characteristics, modelling these characteristics and merging control outputs from the simulator to provide the correct stick / rudder forces. Expectation is to define the hardware required to carry this out and if time permits to build a prototype setup.

4. Drawings
Manufacturing drawings will be required of the force-feel installation into the simulator control system

5. User/client specifications
Use of the SF260 flight manual maintenance manual to determine the aerodynamic characteristics.

6. Outcomes
A full stick force per G diagram will be required, and a design to apply the forces into the control system on all 3 axes.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

Rob Jonker

External Leader Location

Aerosud

External Organisation

Aerosud

Prof KJ Craig

Design linkage mechanism to actuate Compact Linear Fresnel Reflector (CLFR) mirrors

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
CLFR systems are a type of Concentrated Solar Power (CSP) system that uses line concentration and flat mirrors mimicking a Fresnel lens to reflect sun energy onto multiple receivers. Traditionally, each mirror is actuated individually to track the sun and concentrate it onto a specific receiver. Because of the known sun movement, there exists a geometric relationship between adjacent mirrors, and this relationship can be exploited to simplify the actuation of a mirror-set using a linkage mechanism. The linkage will enable the use of fewer actuators, thereby reducing the cost of the overall CLFR system.
b. Problem statement
Perform a linkage design considering dynamics and structural elements for the actuation of the reflectors of a CLFR CSP plant.
c. Objectives of the design
The linkage mechanism must outperform traditional individual reflector actuators in terms of cost, ease of maintenance and stow capability for storm conditions while maintaining tracking accuracy.
Meet user specifications in terms of performance.
Maximise the use of off-the-shelf components.
d. Drawings
Supply a set of drawings of the final designed mechanism.
e. User/client specifications
Tracking accuracy, required actuation forces and moments should match commercially available actuators, typical size of CLFR field to determine modular approach.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design frame for modular heliostat system

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
Concentrated Solar Power (CSP) plants with a central tower receiver use heliostats to focus sun energy on a central point. Current trends in heliostat design are to either make heliostats very large (>140m2 reflector area) or to make them small and cheap. Of the latter, one option is to use a modular structure (e.g., the helioPOD being developed by Stellenbosch University). The aim is to mount heliostat in groups onto a base structure that is modular in nature. This frame must be able to withstand all the loads acting on it, yet be cheap to manufacture and assemble.
b. Problem statement
Design a frame for a modular heliostat system that meets the objective and specifications provided.
c. Objectives of the design
Provide a strong but lightweight structure that meets all requirements of wind loads, tracking accuracy, modular manufacture and construction, ease of maintenance and innovative anchoring and wiring.
Meet user specifications in terms of performance.
Maximise the use of off-the-shelf components.
d. Drawings
Manufacturing drawings of the frame structure.
e. User/client specifications
Wind conditions for wind loads, heliostat reflector size and weight, tracking accuracy, typical actuators (mounting interfaces, weight, etc.), modular control strategy.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design CSP Storage tank using Phase Change Material (PCM)

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
For Concentrated Solar Power (CSP) plants to be a viable alternative to photovoltaic (PV) plants, they must be equipped with thermal storage to operate at night time or during cloudy periods in providing base load power. Current commercial storage systems use sensible heat typically implemented in molten salt tanks or steam accumulators, to name a few examples. Latent heat storage (using the energy associated with a change in phase of a phase change material (PCM)) has great potential as an alternative to sensible heat storage. Depending on the working and heat transfer fluid (HTF), such a tank can have up to three fluid paths that interact thermally. This design considers the scenario where the working fluid (generating electricity) is water; the HTF is a synthetic oil and the tank is filled with the PCM. The interaction between the different fluid paths and the PCM determines the size and layout of the tank that determines the charging/discharging time and hence effective heat transfer.
b. Problem statement
Design a latent storage tank with optimal heat transfer between the heat transfer and working fluid while optimizing the charging/discharging characteristics of the thermal PCM battery.
c. Objectives of the design
Provide a storage tank that competes with sensible heat thermal storage systems in terms of cost, size, complexity and maintenance. Computational Fluid Dynamics (CFD) simulations can be used to evaluate the performance of the design.
Meet user specifications in terms of performance.
Maximise the use of off-the-shelf components.
d. Drawings
Drawings of the storage system.
e. User/client specifications
Operational temperatures and ranges, thermal capacity (hours of storage at what conditions), weight and structural limitations (refer to manufacturing limitations and relevant standards), charging/discharging time.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a rock-bed storage system for a Concentrated Solar Power (CSP) plant

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
Rock-bed storage has been identified as a candidate storage medium for Concentrated Solar Power (CSP) plants to be located in the Karoo because of the free local availability of rock. Dolorite has been identified as an ideal candidate. Different designs of such a storage facility are possible. This project aims to come up with an innovative design that can maximize the storage efficiency. The CSP plant being considered is a pressurized air system using the Brayton cycle in a solarized gas turbine. The rock bed is therefore heated using hot air, but is discharged using water in pipes that is heated for steam electricity generation in a Rankine cycle.
b. Problem statement
Design a rock-bed storage system that meets the requirements stated.
c. Objectives of the design
Provide a storage tank that competes with other sensible heat thermal storage systems in terms of cost, size, complexity and maintenance. The thermal performance of the designed system can be evaluated using Computational Fluids Dynamics (CFD) simulation.
Meet user specifications in terms of performance.
Maximise the use of off-the-shelf components.
d. Drawings
Drawings of the storage system
e. User/client specifications
Operational temperatures and ranges, thermal capacity (hours of storage at what conditions), weight and structural limitations (refer to manufacturing limitations and relevant standards), charging/discharging time

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a cavity receiver for a Compact Linear Fresnel Reflector (CLFR) Concentrated Solar Power (

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
The optical efficiency of a CLFR, a type of multiple receiver line-concentrating Concentrated Solar Power (CSP) plant, can be largely influenced by the optical design of both the primary reflectors (flat mirrors reflecting the sun's energy upwards towards the receivers) and the secondary reflectors (reflecting surfaces located around the receiver/absorber providing additional concentration). An optimally designed system can outperform traditional parabolic trough systems in terms of optical and thermal efficiency. Several methods exist for designing such a receiver-reflector combination, including ray tracing, Computational Fluid Dynamics and optical equations (using trigonometry and optics fundamentals). This topic focuses on the design methodology and then applies it to a few candidate designs for performance evaluation.
b. Problem statement
Design a cavity receiver for a CLFR receiver for optimal optical and thermal efficiency to meet the specified requirements.
c. Objectives of the design
The design must maximize optical performance measures (optical efficiency, concentration factor, Concentration-Acceptance Product (CAP), etc.) and maximize the thermal efficiency (ratio of heat transferred to the heat transfer fluid to that of the incoming solar energy) for a given set of parameters including CLFR field width and height, mirror count and positioning, incoming Direct Normal Irradiation, etc.
d. Drawings
Drawings of cavity receiver
e. User/client specifications
CLFR field parameters (width, height), solar conditions, HTF type and temperature range, mirror properties. Minimal thermal losses.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Trapping the sun with a maze, creating maximum absorption, minimum reflection and re-radiadiation lo

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
Solar tower Concentrated Solar Power (CSP) plants often use cavity receivers. The challenge is typically to utilize the high temperatures that can be obtained by using the sun's energy to heat a heat transfer fluid without have too many thermal losses. These losses normally take the form of convection losses, conduction losses and mainly re-radiation losses at high temperatures. The challenge is therefore to trap the solar rays in such a way that they don't reflect back out of the cavity and to similarly for emitted re-radiation, not to allow view factors that would also imply re-radiation out of the cavity. Some designs that do this are for instance using bent fibre optic cables to reflect the solar energy around a bend to a receiver where the HTF is located. Other use spikes or tower-like pyramids to limit the view factor back to the sun or solar reflector.
b. Problem statement
Design a solar receiver that minimizes thermal re-radiation and reflection losses.
c. Objectives of the design
Increase the thermal performance (efficiency) of the receiver by causing more of the solar irradiation input to be transferred to the HTF. Evaluate the thermal performance using Computational Fluid Dynamics (CFD) to validate the final chosen concept and design.
d. Drawings
Provide a set of drawings that allows manufacturing of the final concept for prototype testing.
e. User/client specifications
Improve the thermal efficiency based on the performance of typical current designs.
Limit the maximum temperature in the cavity receiver based on material constraints.
f. Outcomes
An improved cavity receiver design compared to existing commercial designs.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Off-the-grid electricity, energy and water supply for house in Gauteng conditions

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
With the ever-increasing rise in cost of utilities like electricity and water, the availability of self-generated thermal energy, electricity and self-stored water in a new luxury housing development is considered to be an advantage. When these features are incorporated into the architectural design of the building, a more cost-effective, integrated and elegant design is possible. Sources of thermal energy include solar water geysers and swimming pool heaters as well as concentrated solar thermal and geothermal (heat pipes). Electricity can be generated using pholto-voltaic principles or using thermal sources like biomass. Wind power is not to be considered as source in Gauteng. Rain-water harvesting and filtering and storage is to be included.
b. Problem statement
Design an energy system for a luxury house that strives towards off-the-grid living in terms of electricity, thermal energy (heating and cooling) and water supply.
c. Objectives of the design
Meet user specifications in terms of performance.
Maximise the use of off-the-shelf components.
Combine existing technologies for this specific application in a cost-effective manner.
d. Drawings
Solid model of energy and water supply and storage system with detail drawings of engineered parts (TBD)
e. User/client specifications
Typical usage profiles, location, availability requirements for sources (electricity kWh/person/day; thermal requirements (comfort, etc.); water usage; cost of energy)

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Dewatered Sewerage Sludge Unloading Trailer

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
After anaerobic digestion, a certain amount of sewerage sludge is left that must be disposed of. This sludge is usually dewatered in belt presses, and the dewatered sludge is then spread on large concrete beds to dry. Once dry, the sludge can be used as a fertiliser concentrate. The trailer is required as a unit that can be loaded with dewatered sludge at the belt presses directly from the press output conveyors, transport the sludge to the drying bed, and unload the sludge at the drying bed.
b. Problem statement
Design a trailer that can be filled with 6 m3 dewatered sewerage sludge and that can unload the sludge in an even flat layer, while being drawn behind an agricultural type tractor.
c. Objectives of the design
Meet user specifications in terms of performance.
Maximise the use of off-the-shelf components.
d. Drawings
Concept alternatives, general assembly, and selected component drawings as required for MOX 410.
e. User/client specifications
• 10 m3 volume per load
• PTO powered by tractor (specify requirements)
• Economical to acquire, operate and maintain
• Robust
• Low turnaround time
• Suited for off-the-road operation
f. Outcomes
A design report where the student firstly demonstrates an understanding of the basic Waste Water Treatment Works functioning, and the definition of the dewatered sludge from the belt presses, culminating in a suggested design for an economical sludge unloading trailer.
Externally led by Mike Nieuwoudt PrEng

Category

Mechanical

Group

Thermofluids Research Group

External Leader

Mike Nieuwoudt PrEng

External Leader Location

Pretoria

External Organisation

N/A

Tractor Drawn Street Sweeper

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
A neat place of work instills a sense of pride in the people employed. Industrial sites, and their paved roads and surfaces, are often neglected with leaves, sand, papers and other general waste often littering the roadways. With reduced number of personnel being employed as general street cleaners, it is advantageous to have an economical street sweeping machine on industrial sites to assist the limited number of site cleaning personnel with the task of keeping these paved surfaces neat and clean.
b. Problem statement
Design a horizontal rotary brush sweeping machine that can be attached to a tractor to sweep the asphalt and concrete roads on industrial sites, while being drawn behind an agricultural type tractor.
c. Objectives of the design
Meet user specifications in terms of performance.
Maximise the use of off-the-shelf components.
d. Drawings
Concept alternatives, general assembly, and selected component drawings as required for MOX 410.
e. User/client specifications
• Sweep at a speed of approximately 10 km/h
• PTO powered by tractor (specify requirements)
• Easy and quick to attach / detach from tractor
• Economical to acquire, operate and maintain
• Robust
f. Outcomes
A design report where the student firstly demonstrates an understanding of principles involved in road sweeping with rotary brushes, culminating in a suggested design for an economical sweeping machine that can be used on industrial sites.
Externally led by Mike Nieuwoudt PrEng

Category

Mechanical

Group

Thermofluids Research Group

External Leader

Mike Nieuwoudt PrEng

External Leader Location

Pretoria

External Organisation

N/A

Mechanical Broad Head Arrow Tip Design

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
Bow hunting has become a popular pass time and sport practiced by thousands of people over the world. In modern archery, the bows and arrows have become highly technical equipment. Part of the system is the arrow tip, also called a broad head, which cut into the target, with the purpose of causing massive bleeding that will immobilise the target in the shortest possible time. Cutting diameters of 50mm is not uncommon. For a fixed blade broad head with a large cutting diameter, the blades have a large influence on the flight characteristics of the arrow leading to inaccurate flight. This led to the development of so-called mechanical broad heads, where the blade is folded and only opens to the cutting diameter when it impacts the target.
b. Problem statement
Design, and simulate the action and flight characteristics of, a multi-blade mechanical broad head for mounting to a hunting arrow.
c. Objectives of the design
Conceptualise and design a multi-blade broad head.
Simulate the opening action of the blades on impact with the target animal
Simulate the flight characteristics of the arrow with this broad head, and its influence on arrow flight relative to a smooth steel tip.
d. Drawings
Concept alternatives, general assembly, and selected component drawings as required for MOX 410.
e. User/client specifications
• Mechanical broad head in the 100 to 125 grain size.
• Predictable and accurate flight characteristics
• Minimum 40 mm cutting diameter
• Standard arrow threaded mounting interface.
• Suitable for repeated use
f. Outcomes
A design report where the student demonstrates the ability to conceptualise and design a small functional mechanical component, and simulates its functional characteristics to ensure a high probability of success if developed further, culminating in a suggested design for a mechanical broad head.
Externally led by Mike Nieuwoudt PrEng

Category

Mechanical

Group

Thermofluids Research Group

External Leader

Mike Nieuwoudt PrEng

External Leader Location

Pretoria

External Organisation

N/A

Sand-Blasting Machine

Lecturer, Prof KJ Craig
Max students, 1

Project Description

a. Background
Several general designs are used for sand blasting of metals in the engineering industry. Different principles are used to mix the blasting medium (sand, grit, beads) with the high pressure high velocity air used in the blasting. Both pressurised and open sand pots are used, with the blasting gun being of single or dual line construction. A pressurised sand pot is classified as a pressure vessel, and it is thus advantageous to have a machine that can work with an open sand pot as it reduces the statutory requirements for its design, manufacture and operation. A good blasting gun also ensures supersonic exit velocity from the blasting nozzle, and a focused blasting stream of sand.
b. Problem statement
Design a sand-blasting machine suitable for general small engineering workshops, with its associated sand blasting gun, that use an open unpressurised sand pot and dual lines for feeding the air and sand to a double venturi type sand blasting gun.
c. Objectives of the design
Conceptualise the design
Meet user specifications in terms of performance.
Use appropriate simulations to verify the performance of the gun design.
d. Drawings
Concept alternatives, general assembly, and selected component drawings as required for MOX 410.
e. User/client specifications
• Air flow required not to exceed 160 SCFM at a source pressure of 7 bar maximum.
• Must be able to blast media from 0.2 to 2mm in diameter.
• Materials selected for equipment, especially the gun, must be able to withstand high abrasive wear experienced in the intended use.
• Machine will be utilised 4 hrs/day, 5 days per week.
f. Outcomes
A design report where the student firstly demonstrates an understanding of the basic gas- and thermodynamic principles needed for the sand blasting process, culminating in a suggested design for the machine and blasting gun.
Externally led by Mike Nieuwoudt PrEng

Category

Mechanical

Group

Thermofluids Research Group

External Leader

Mike Nieuwoudt PrEng

External Leader Location

Pretoria

External Organisation

N/A

Dr J Dirker

Latent Heat Storage Facility

Lecturer, Dr J Dirker
Max students, 5

Project Description

1. Background

The energy consumption of air conditioning and refrigeration systems makes up a significant component of the utility bill of commercial property owners. The capitol lay-out cost of such systems are also significant, especially if the systems are sized according to the peak cooling loads during the day (normally between 13:00 and 16:00). In order to reduce the thermal rating size of such systems, latent storage facilities are employed by which excess cooling capacity is used during the night to solidify a fluid (using for instance water). During peak cooling loads, a portion of the cooling is supplied via the latent heat storage facility and the solidified material is melted, which makes available the latent heat component. This also reduces the peak electricity demand on ESKOM and other power utility companies by charging the facility at night and discharging it during the day.

2. Problem statement
Design a latent heat storage module using a fluid of your choice to allow for a shift of about 30% of total cooling load away from refrigeration plant during the day. It must be able to interact with i) the evaporator of a Refrigeration plant and ii) with a chilled water loop forming the thermal link to the cooled commercial space.

3. Objectives of the design
- Produce relevant conceptual lay-outs of the module.
- Select a suitable phase change material to be used for latent heat storage as well as the refrigerant temperature during the charging phase.
- Iteratively obtain the applicable heat transfer coefficient and the required heat transfer surface areas based on selected and anticipated mass flow rates of the chilled water (discharge mode) and refrigerant (charge mode).
- Determine a packaging solution of the heat transfer surface areas to sustain sufficient heat transfer rates.
- Select / Size all interface components and tubing to limit pressure drop and entropy generation.
- The structural lay-out of module must be suitable to be reliable, safe and sturdy.
-Manufacturing, maintenance and operating procedures are to be taken into consideration.

4. Drawings
A full assembly drawing of the module is to be created, which will clearly show the required sizes, geometries of all components and sub-assemblies. Detail hand and CAD drawings of selected components are to be prepared.

5. User/client specifications
The latent heat storage capacity of the module must be in total 300 MJ, 400 MJ, 500 MJ, 600 MJ or 800 MJ. Minimum discharge and charge heat transfer rate must be 7.5 kW 10 kW, 12.5 kW, 15 kW or 20 kW respectively.
Chilled water exit temperature during discharge must be between 10°C and 13°C.

6. Outcomes
Refer to the study guide for ECSA outcomes.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Industrial Thermo-syphon Evaporator

Lecturer, Dr J Dirker
Max students, 5

Project Description

1. Background
Evaporators play a vital role in vapour compression refrigeration systems and are responsible for heat extraction from the cooled medium or space. Liquid submerged evaporators operating on a thermo-syphon principle has several advantages that improve reliability and effectiveness of heat transfer to the refrigerant working fluid. These include protection of the compressor against liquid, and the prevention of dry-out within the evaporator.

2. Problem statement
An industrial thermo-syphon evaporator module is to be designed which will sustain the required heat transfer rate and liquid recirculation rates needed. Care is to be taken to maintain fully liquid submersion and compressor protection.

3. Objectives of the design
- Produce relevant conceptual lay-outs of the module.
- Iteratively obtain the applicable heat transfer coefficient and the required heat transfer surface areas based on selected and anticipated mass flow rates.
- Determine a packaging solution of the heat transfer surface areas to sustain sufficient refrigerant mass-flow circulation.
- Select / Size all interface components and tubing to limit pressure drop and entropy generation.
- The structural lay-out of module must be suitable to be reliable, safe and sturdy.
- Manufacturing and maintenance procedures are to be taken into consideration.

4. Drawings
A full assembly drawing of the module is to be created, which will clearly show the required sizes, geometries of all components and sub-assemblies, including mounting points of the standard components such as tubes, valves etc.. Detail hand and CAD drawings of selected components are to be prepared.

5. User/client specifications
Cooled medium: Liquid water. Water exit temperature: 5°C or 10°C.
Refrigerant: R134a. Evaporator Sizing: 100 kW, 200 kW, 300 kW, 400 kW, or 500 kW.
Height restriction: 4 m.

6. Outcomes
Refer to the study guide for ECSA outcomes.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Prof PS Els

Structural weight reduction on Baja

Lecturer, Prof PS Els
Max students, 1

Project Description

Background: The Baja vehicle is designed to maximize its performance during operation, thus the weight of the structure and the stresses in the structure affect the performance of the vehicle. The structure also has to conform to safety rule requirements. The stucture therefore needs to be as light as possible, but still conform to the rules. This design project must be performed by the same student doing the MSC Structural weight reduction on Baja research project.

Problem statement: Analyze the existing Baja vehicles structure in order to determine the areas in which the mass can be reduced. Develop light weight concepts for critical areas such as suspension, seat , steering and safety harness mountings. Quantify weight reductions obtained through clever design.

Objectives of the design: Reduce weight while ensuring compliance to the rules as well as acceptable fatigue life

Drawings: Frame members, suspension, steering and drivetrain mountings

Client Specification: Reduction of structural mass in order to improve performance. Elimination of stress concentrations. Feasibility of manufacturing using in-house equipment

Outcomes: A lighter frame with the same life as the existing frame

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Baja rear suspension design

Lecturer, Prof PS Els
Max students, 1

Project Description

Background: Baja SAE is an intercollegiate design event whereby students design, manufacture, assemble and race an all-terrain Baja vehicle. The rough terrain provides for various design opportunities and constant improvement by implementing designs practically. This design must be performed by the same student doing the MSC Baja rear suspension development research project.

Problem statement: The TuksBaja vehicle is currently making use of a double wishbone suspension in the front and an H - arm with dogleg setup for the rear. The suspension has been a problem in the past with a short fatigue life and cracks appearing after the four hour endurance race. The current design for the rear suspension arms do not allow for ease of travel over large obstacles, which also contributes to the low fatigue life.

Objectives of the design: Design a suspension system capable of withstanding the forces and torque which the suspension sees during the endurance race, for a longer fatigue life, while keeping the manufacturing and cost influence under consideration.

Drawings: Suspension layout. Suspension details. Frame mounting details. Drivetrain interface details.

User/client specifications: The client specifications are as follows: Maximize the fatigue life, Stay within the required Baja SAE rules, Account for manufacturability and cost

Outcomes: Design a new rear suspension system for the Baja vehicle that is simple and easy to manufacture. It must be lighter and more reliable than the current suspension system.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Baja steering system

Lecturer, Prof PS Els
Max students, 1

Project Description

Background: The Tuks Baja vehicle steers poorly at low speeds. As a result the vehicle scores poorly in maneuverability events, as well as in suspension and traction events. This design project must be performed by the same student doing the Baja low-speed steering improvement research project.

Problem statement: Design a four wheel steering system for the Tuks Baja. The design must not change the current drivetrain. The design weight must be kept at a minimal.

Objectives of the design: To reduce the turning radius of the Baja at low speed.

Drawings: Detailed drawings with dimensions, tolerances, weld symbols, etc will be included. The drawings include racks, pinions, tie rods, uprights, hubs, wheels, shafts and steering wheel.

Client specifications: Reduce the low-speed turning radius of the vehicle by 30%. No changes to the drive train should be made. Minimise the mass of the system as far as possible

Outcomes: A four wheel steering system that is expected to improve the low-speed steering considerably whilst having negligible impact on the current vehicle drivetrain and mass.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Magneto-rheological (MR) fluid damper for Baja

Lecturer, Prof PS Els
Max students, 1

Project Description

Background: Vehicle ride comfort and handling are often at extremes of the design space. One way of improving ride comfort and handling is to use adjustable or semi-active dampers. One of the most popular methods for implementing semi-active dampers is through use of magneto-rheological (MR) fluids. The viscosity of these fluids are dependent on the strength of the magnetic field applied to the fluid. Damping can easily be changed by controlling the magnetic field. This design projects needs to be performed by the same student doing the Magneto-rheological (MR) fluid damper for Baja research project.

Problem statement: Design a semi-active damper using MR fluids to replace the current hydraulic damper on a Baja vehicle

Objectives of the design: The MR damper should fit into the existing space envelope and produce a damper force range that encompasses the full range of current possible damper values

Drawings: Damper valve, solenoid coil, damper housing, sealing arrangement

User/client specifications: The damper must be able to deliver damping forces in a range both higher and lower than that currently available on the Baja suspension. The damper must integrate seamlessly with the current hydropneumatic spring and existing suspension mountings. The damper must have a quick response time (i.e. low coil inductance)

Outcomes: Design of a MR damper that can provide a large range of adjustability and fit seamlessly into the existing suspension design

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mr KP Grimsehl

Design a lifting crane that will be mounted onto a bakkie (Bursar topic for 11018896)

Lecturer, Mr KP Grimsehl
Max students, 1

Project Description

1. Background
De Beers is interested in exploring the development of a lifting crane for there bakkies. Such a lifting crane will assist the mine because it can:
o improve safety in lifting heavy items
o Only one person needed to lift items
o No need to always use a large crane and large crane truck for smaller components
o Small LDV is versatile to go into confined areas in the plant
o Don’t need to have a heavy duty licence to drive this vehicle compared to a crane truck
o It will assist female artisans and operators in the work place with heavy items which they cannot lift on their own

2. Problem statement
Design a lifting crane to be mounted on a Toyota 4x4. The crane must be able to lift up to 400 kg. Items to be lifted include: Small pumps, Small motors, Toolboxes, Pump impeller, volute, barrel, Portable generator sets, Portable welding machines, Air conditioner units, Bags of cement on a pallet etc.
The crane will be used by trained and untrained personnel.

3. Objectives of the design
Deliver a complete design including mounting points of a lifting crain mounted on a single and double cab Toyota 4x4 bakkie.

4. Drawings
Complete set

5. User/client specifications
a device that can be mounted to the back of a specific bakkie and must be able to lift a weight of up to 400kg onto the back of the bakkie.
Items to consider include (but not limited to):
o Effect of lifting crane on the functionality of the vehicle
o Interference with roll over device already fitted onto the LDV
o Safety when device not in use
o Additional modifications required to vehicle
o Training of the operator
o Safety devices
o Conformance with any SABS standards (if there are any)

6. Outcomes
Calculations of the stresses in the system and any other additional calculations required that were made to verify the efficacy of the device.
Detailed FMEA (failure mode and effects analysis) and risk assessment.
Any labeling and instructions for use that will be required
Specify the materials to be used and the manufacturing methods. Perform a cost estimate and determine the payback period of the system.
A report needs to be submitted as prescribed by the study guide

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Manual espresso machine

Lecturer, Mr KP Grimsehl
Max students, 3

Project Description

1. Background
An espresso is a coffee beverage where hot water is forced under pressure through the coffee ground. In a manual coffee machine this force is applied by the user - this creates an espresso shot where every aspect of the brew is under the control of the operator. (In comparison a semi-automatic espresso machine uses a pump to force the water through the ground)

2. Problem statement
Develop a manual coffee machine capable of delivering a professional quality espresso shot. The machine must be priced to compete with entry level semi-automatic machines currently on the market.

3. Objectives of the design
Design a manual espresso machine

4. Drawings
Complete set

5. User/client specifications
A manual espresso machine capable of delivering a professional quality shot.

6. Outcomes
Calculations of the stresses in the system and any other additional calculations required that were made to verify the efficacy of the device.
Detailed FMEA (failure mode and effects analysis) and risk assessment.
Any labeling and instructions for use that will be required
Specify the materials to be used and the manufacturing methods. Perform a cost estimate and determine the payback period of the system. A report needs to be submitted as prescribed by the study guide

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design on a non-motorized off-road wheelchair

Lecturer, Mr KP Grimsehl
Max students, 3

Project Description

1. Background
Most current wheelchairs struggle on loose uneven ground and grass

2. Problem statement
Develop a non-motorized wheelchair for an active paraplegic's daily use - the wheelchair will be used in a semi-urban environment - this includes grass, loose ground, broken sidewalks as well as paved areas and indoor environments

3. Objectives of the design
Design a non-motorized wheelchair for an active paraplegic for daily use over rough terrain

4. Drawings
Complete data pack

5. User/client specifications
a non-motorized wheelchair for an active paraplegic's daily use - the wheelchair will be used in a semi-urban environment - this includes grass, loose ground, broken sidewalks as well as paved areas and indoor environments
The unit should be strong, rugged and light

6. Outcomes
Calculations of the stresses in the system and any other additional calculations required that were made to verify the efficacy of the device.
Detailed FMEA (failure mode and effects analysis) and risk assessment.
Any labeling and instructions for use that will be required
Specify the materials to be used and the manufacturing methods. Perform a cost estimate and determine the payback period of the system. A report needs to be submitted as prescribed by the study guide

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Access device for wheelchair bound/old and obese passengers into light aircraft

Lecturer, Mr KP Grimsehl
Max students, 3

Project Description

1. Background
Light aircraft are often used to transport passenger into more remote areas. Some of these passengers might be obese, old or wheelchair bound. Access into and out of light aircraft's for these patients might be problematic

2. Problem statement
Access into light aircraft may be problematic for obese, old or wheelchair bound passengers

3. Objectives of the design
Develop a device that will assist these passengers to enter/exit from a light aircraft.
The device must be able to work with a wide range of passengers

4. Drawings
A drawing data pack including an assembly and where applicable sub-assembly drawings

5. User/client specifications
An easily transportable device that will assist obese, old and wheelchair bound patients to ente into/exit from a light aircraft

6. Outcomes
Calculations of the stresses in the system and any other additional calculations required that were made to verify the efficacy of the device.
Detailed FMEA (failure mode and effects analysis) and risk assessment.
Any labeling and instructions for use that will be required
Specify the materials to be used and the manufacturing methods. Perform a cost estimate and determine the payback period of the system. A report needs to be submitted as prescribed by the study guide

Category

Aeronautical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Prof PS Heyns

Dr H Inglis

Design of fracture mechanics experimental setup for variable geometries

Lecturer, Dr H Inglis
Max students, 4

Project Description

1. Background
The geometry of cracked specimens has a strong impact on their fracture behaviour. In order to investigate these effects for a four-point bend specimen, it is necessary to design a test setup which allows variation of critical geometric features. The use of PMMA (perspex) specimens will also allow photoelastic techniques to visualise stress fields ahead of the crack tip.

Relevant literature
Aliha, M. R. M., Ayatollahi, M. R. (2010) “Geometry effects on fracture behaviour of polymethyl methacrylate,” Materials Science and Engineering A, 527:526-530

Bittencourt, T. N., Wawrzynek, P. A., Ingraffea, A. R., Sousa, J. L. (1996) “Quasi-automatic simulation of crack propagation for 2D LEFM problems,” Engineering Fracture Mechanics, 55:321-334.

2. Problem statement
Design the experimental setup to conduct four point bend fracture mechanics tests on perspex samples with varying geometry. This includes design of the sample as well as all attachments and instrumentation.

3. Objectives of the design
Experimental setup to conduct fracture mechanics tests with varying geometry.

4. Drawings
Experimental setup
Experimental samples

5. User/client specifications
Must perform four point bend test of pre-cracked perspex samples
Standalone testing machine
Adjustable sample size and loading points
Includes design of sample and instrumentation

6. Outcomes
Experimental setup to conduct fracture mechanics tests with variable geometries.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of fracture mechanics experimental setup for variable geometries

Lecturer, Dr H Inglis
Max students, 1

Project Description

1. Background
The geometry of cracked specimens has a strong impact on their fracture behaviour. In order to investigate these effects for a four-point bend specimen, it is necessary to design a test setup which allows variation of critical geometric features. The use of PMMA (perspex) specimens will also allow photoelastic techniques to visualise stress fields ahead of the crack tip.

Relevant literature
Aliha, M. R. M., Ayatollahi, M. R. (2010) “Geometry effects on fracture behaviour of polymethyl methacrylate,” Materials Science and Engineering A, 527:526-530

Bittencourt, T. N., Wawrzynek, P. A., Ingraffea, A. R., Sousa, J. L. (1996) “Quasi-automatic simulation of crack propagation for 2D LEFM problems,” Engineering Fracture Mechanics, 55:321-334.

2. Problem statement
Design the experimental setup to conduct four point bend fracture mechanics tests on perspex samples with varying geometry. This includes design of the sample as well as all attachments and instrumentation.

3. Objectives of the design
Experimental setup to conduct fracture mechanics tests with varying geometry.

4. Drawings
Experimental setup
Experimental samples

5. User/client specifications
Must perform four point bend test of pre-cracked perspex samples
Standalone testing machine
Adjustable sample size and loading points
Includes design of sample and instrumentation

6. Outcomes
Experimental setup to conduct fracture mechanics tests with variable geometries.

Category

Aeronautical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Crush test of energy-absorbing composite cylinders

Lecturer, Dr H Inglis
Max students, 4

Project Description

1. Background
To mitigate injury and loss of life in helicopter crashes, helicopter seats have energy-absorbing capabilities, such as sacrificial composite cylinders which will dissipate substantial energy as they are crushed during impact.

2. Problem statement
Design the experimental setup and samples for crush testing of composite cylinders, used for energy absorption in crash scenarios. The setup should accommodate different geometries for the interface with the cylinder. The test setup needs to record the energy dissipated throughout the test.

This includes design of the sample as well as all attachments and instrumentation.

3. Objectives of the design
Experimental setup for crush testing of composite energy-absorbing cylinders.

4. Drawings
Experimental setup
Experimental samples

5. User/client specifications
Must perform crush testing of energy-dissipation cylinders
Variable shape of interface
Must measure energy absorbed during impact
Includes design of sample and instrumentation

6. Outcomes
Experimental setup for composite cylinder crush tests.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Crush test of energy-absorbing composite cylinders

Lecturer, Dr H Inglis
Max students, 1

Project Description

1. Background
To mitigate injury and loss of life in helicopter crashes, helicopter seats have energy-absorbing capabilities, such as sacrificial composite cylinders which will dissipate substantial energy as they are crushed during impact.

2. Problem statement
Design the experimental setup and samples for crush testing of composite cylinders, used for energy absorption in crash scenarios. The setup should accommodate different geometries for the interface with the cylinder. The test setup needs to record the energy dissipated throughout the test.

This includes design of the sample as well as all attachments and instrumentation.

3. Objectives of the design
Experimental setup for crush testing of composite energy-absorbing cylinders.

4. Drawings
Experimental setup
Experimental samples

5. User/client specifications
Must perform crush testing of energy-dissipation cylinders
Variable shape of interface
Must measure energy absorbed during impact
Includes design of sample and instrumentation

6. Outcomes
Experimental setup for composite cylinder crush tests.

Category

Aeronautical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of an automatic device to play “Fetch” with a dog

Lecturer, Dr H Inglis
Max students, 4

Project Description

1. Background
Many dogs are left at home for long hours while their owners are at work or university. The dogs can become bored, and do not get enough exercise. This can be mitigated by dog toys which deliver treats when the dog interacts with them.

2. Problem statement
Design a mechanical device which can throw a ball for a dog. The dog should be able to reload the device by returning the ball to a cup or collector, and this action should deliver a treat. The device should not require human intervention, but should be triggered by the dog.

3. Objectives of the design
Design of a dog entertainment and exercise system which does not require human intervention

4. Drawings
Dog exercise system

5. User/client specifications
Must throw a ball with a random speed and trajectory
Must be reloaded by the dog returning the ball
Successful return of the ball should deliver a treat to the dog
As many elements as possible of the design should be mechanical (rather than electronic)
Should not require human intervention

6. Outcomes
Design of a dog entertainment and exercise system which does not require human intervention

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Dr CJ Kat

Adjustable seated biceps curl resistance training machine

Lecturer, Dr CJ Kat
Max students, 4

Project Description

1. Background
In the study of Nolte, Krüger and Els (2011) the benefits and limitations of using 3D musculoskeletal modelling in assessing the safety and efficacy of exercising on a seated biceps curl resistance training machine was evaluated. LifeModeler™ was used to study three anthropometric cases i.e. a 5th percentile female, as well as a 50th and 95th percentile male. The study concluded that the modelling was able to highlight anthropometric differences with regards to the biceps curl resistance training machine's engineered adjustability. A seat biceps curl machine has been designed, manufactured and is available to perform test on exercisers in order to obtain experimental measurements to validate the model in Nolte, Krüger and Els (2011).

2. Problem statement
The available seated biceps curl machine is adjustable, however adjustments take too much time and does not allow for the effective investigation of the effect of adjustability on the efficacy and safety of the exerciser.

3. Objectives of the design
The re-design of the machine's adjustability is required in order to allow for quick, easy and effective adjustment of the seated biceps curl.

4. Drawings
Drawings of the fully adjustable bicep curl machine have to be made

5. User/client specifications
The machine has to have a wide range of adjustability of the various components. Included in this range of adjustability should be the dimensions of the machine used in Nolte, Krüger and Els (2011).

6. Outcomes
A bicep curl machine that allows for quick, easy and effective adjustment of its various components.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Canine spine segment model for verifying test rigs

Lecturer, Dr CJ Kat
Max students, 2

Project Description

1. Background
Lumbosacral fracture-luxations are most commonly seen in younger dogs as a result of motor vehicle trauma (Seim, 2002). Since any instability over a fracture line will result in delayed healing and excessive callus formation, the ideal fixation methods should be able to withstand even minimal angular deformation. Various fixation methods exist having different advantages and disadvantages. It is required that these fixation techniques be tested in order to quantify their strength and determine their mode of failure. For this purpose various test rigs exist and have been used but many of these test rigs do not load the spine segment in the same way. This makes it difficult to compare results between studies using different test rigs.

2. Problem statement
A spine segment model is required that can be used to verify a test rig. The spine segment model should be representative of the spine from the sacrum to the 5th lumbar vertebra (L5).

3. Objectives of the design
A spine segment model has to be designed that is representative of the spine from the sacrum to the 5th lumbar vertebra (L5). The spine segment model has to be such that the bending stiffness of the various joints can be adjusted, independently from one another.

4. Drawings
Drawings of the canine spine segment model have to be made

5. User/client specifications
The spine segment model has to be representative of the spine from the sacrum to L5. The bending stiffness of each joint in the model has to be independently adjustable. The spine segment model must be able to interface with the Free-Bending Canine Spine (FBCS) test rig.

6. Outcomes
A spine segment model of a canine spine from the sacrum to the 5th lumbar vertebra (L5) with adjustable joint stiffness's.

The spine segment model can be manufactured for use in the MSC project that aims at verifying and modelling the spine segment model. It is strongly suggested that this MOX project is taken with the corresponding MSC project.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Canine spine segment model for testing fixation techniques

Lecturer, Dr CJ Kat
Max students, 2

Project Description

1. Background
Lumbosacral fracture-luxations are most commonly seen in younger dogs as a result of motor vehicle trauma (Seim, 2002). Since any instability over a fracture line will result in delayed healing and excessive callus formation, the ideal fixation methods should be able to withstand even minimal angular deformation. Various fixation methods exist having different advantages and disadvantages. It is required that these fixation techniques be tested in order to quantify their strength and determine their mode of failure.

2. Problem statement
In order to test and compare the various fixation techniques these fixation methods have to be applied to spine segments harvested from cadavers. It is difficult to get spine segments that are exactly similar and this makes comparison between fixation techniques difficult as there are a lot of variation introduced by the cadaver spine specimens that are used.

3. Objectives of the design
Design a spine segment model that is representative of the lumbar spine. The spine segment model has to be such that different fixation techniques can be tested on it.

4. Drawings
Drawings of the canine spine segment model have to be made

5. User/client specifications
The spine segment model has to be able to test different fixation techniques and should specifically be able to test the Four Pin and Polymethylmethacrylate (PMMA) and the “Sting-of-pearls” (SOP) Interlocking Plate fixation methods. The joint stiffness should be able to be adjustable. The spine segment model must be able to interface with the Free-Bending Canine Spine (FBCS) test rig.

6. Outcomes
A spine segment model of a canine lumbar spine that can be used to test and compare different fixation techniques.

The spine segment model can be manufactured for use in the MSC project that aims at verifying and modelling the spine segment model. It is strongly suggested that this MOX project is taken with the corresponding MSC project.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Canine spine segment test rig for full physiological loading

Lecturer, Dr CJ Kat
Max students, 2

Project Description

1. Background
Lumbosacral fracture-luxations are most commonly seen in younger dogs as a result of motor vehicle trauma (Seim, 2002). Since any instability over a fracture line will result in delayed healing and excessive callus formation, the ideal fixation methods should be able to withstand even minimal angular deformation. Various fixation methods exist having different advantages and disadvantages. It is required that these fixation techniques be tested in order to quantify their strength and determine their mode of failure.

2. Problem statement
In order to test fixation techniques various test rigs exist and have been used but many of these test rigs do not load the spine segment in the same way or in a physiologically correct way. This makes it difficult to compare results between studies using different test rigs as well as quantify whether the fixation technique will be able to withstand the loadings that it will experience in vivo.

3. Objectives of the design
Design a test rig that is able to load a canine lumbar spine with the correct physiological loads.

4. Drawings
Drawings of the canine spine segment model have to be made

5. User/client specifications
The test rig should be able to test the lumbar spine of a dog. The test rig should be able to at least test the section of spine from the sacrum to the 5th lumbar vertebra (L5). The test rig should be able to load the spine in a physiologically correct way.

6. Outcomes
A test rig that is able to load a canine lumbar spine with the correct physiological loads.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Prof S Kok

Design of an automatic farm gate opener

Lecturer, Prof S Kok
Max students, 3

Project Description

1. Background
Farmers and farm workers have to open numerous gates manually during any working day. These gates are normally closed to prevent game or cattle from wandering into the wrong camps.

2. Problem statement
Design an automatic gate opener that is only triggered by the weight of a tractor or bakkie. The gate has to open in a slow, controlled manner due to the weight of the vehicle. After the vehicle drives through the gate, the gate has to close in a slow, controlled manner. If the gate is locked manually (e.g. a padlock), the presence of the vehicle may not damage the mechanism. The design must also cater for manual operation by a pedestrian, and may not be triggered by a large animal.

3. Objectives of the design
The objective of the design is to open and close farm gates automatically when the device is triggered by the weight of a vehicle.

4. Drawings
Assembly drawing and detail manufacturing drawing as per study guide.

5. User/client specifications
Design an automatic gate opener that is only triggered by the weight of a tractor or bakkie.

6. Outcomes
All steps detailed in the study guide

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a wheel lifter dolly

Lecturer, Prof S Kok
Max students, 4

Project Description

1. Background
It is often quite difficult to precisely position a spare tyre (aligning the bolt holes) due to limited strength of the person changing the tyre. This is especially true of heavy duty truck tyres, or 4WD tyres.

2. Problem statement
Design a wheel lifter dolly that can be used to position a heavy duty spare tyre precisely, when replacing a tyre in the field. The design must be sufficiently compact that any 4WD vehicle and truck can store the device in the cab.

3. Objectives of the design
The objective of the design is to ease the burden on a person changing a heavy duty tyre in the field.

4. Drawings
Assembly drawing and detail manufacturing drawing as per study guide.

5. User/client specifications
Design a wheel lifter dolly that can be used to position a heavy duty spare tyre precisely, when replacing a tyre in the field. The design must be sufficiently compact that any 4WD vehicle and truck can store the device in the cab.

6. Outcomes
All steps detailed in the study guide

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a safe squat cage

Lecturer, Prof S Kok
Max students, 3

Project Description

1. Background
The squat is one of the most beneficial weight training exercises. However, due to the heavy weights involved, it is also one of the most dangerous. A safe environment to perform this exercise is hence essential.

2. Problem statement
Design a safe squat cage that does not hamper the natural movement during a heavy squat exercise. A Smith machine solution is thus not permissible. A standard squat cage is also not acceptable. The solution has to provide (near) immediate support whenever the athlete cannot complete the rep.

3. Objectives of the design
The objective of the design is to provide a safe environment for athletes that perform heavy squat exercises.

4. Drawings
Assembly drawing and detail manufacturing drawing as per study guide.

5. User/client specifications
Design a safe squat cage that does not hamper the natural movement during a heavy squat exercise. The solution has to provide (near) immediate support whenever the athlete cannot complete the rep.

6. Outcomes
All steps detailed in the study guide

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Ms NM Kotze

Design of a Flue-Gas Boiler

Lecturer, Ms NM Kotze
Max students, 4

Project Description

1. Background

At Richards Bay Minerals the main products delivered are mainly pig iron and titanium dioxide. These heavy minerals are extracted from the nearby coastal dunes in Richards Bay, KwaZulu Natal. During the extraction process the heavy minerals that have been separated pass through the smelter. These heavy minerals are heated to extremely high temperatures during this process. As a result of this process a gas mixture, predominantly made up of CO2, is released into the air at very high temperatures. This gas mixture expelled into the air contains great potential energy in the form of heat that is now lost to the atmosphere instead of being converted into useable energy.

2. Problem statement

Heat released in the form of a heated gas being expelled by the smelter plants need to be converted into useable energy. Turbines were already bought and a boiler design must be done utilising the given turbines in the electricity generating cycle.

3. Objectives of the design

The main objective of this design is to utilise energy, being lost to the environment in the form of heat, to heat water in a boiler to steam. This steam will then pass through a turbine which will generate electricity. Thus the current heat that is being lost to the environment will be converted into electricity.
By generating the electricity the mine's need for power from generators and Eskom will be lowered, which will lower the amount of money spent yearly on electricity costs.
Thus the three main objectives of this design is as follows:
• Generating electricity instead of losing energy into the atmosphere.
• Lowering electricity costs.
• Lowering Eskom dependence.

4. Drawings
Assembly and components drawings of the CO2 gas boiler

5. User/client specifications
The only client specifications are that the boiler design must be done keeping already bought turbines in mind and that the released CO2 gas needs to be the heating agent. Thus the turbine specifications are given and the gas mixture's heat is known.

6. Outcomes
An efficient boiler that using the existing available plant.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Wind Aerofoil for Highway Lighting

Lecturer, Ms NM Kotze
Max students, 4

Project Description

1. Background

Due to the shortages in electricity in South Africa and its rising costs, street lights are often left unlit. Municipalities are also less inclined to install lighting posts on highways due to the same reasons. However, highway lighting allows for much safer road conditions.

2. Problem statement

Design a maintenance friendly wind driven aerofoil that can be installed on a highway to generate power for highway lighting.

3. Objectives of the design

1) It must be easy to install and standardized so that it can be used on any highway in South Africa.
2) The aerofoil should be designed such that the wake of the passing cars as well as wind can be used to turn it.
3) The lighting is only required when it is night time or when the road conditions are poor (such as poor light due to rain) thus the power generated must EITHER power a battery or directly power the lighting.
4) A new detailed design, with drawings, is required for the aerofoil, the framework in which it is fixed as well as any rotating elements (except the bearings which can be bought off the shelf).
5) All components must be sized and can be bought off the shelf, such the mechanism where the rotating energy is converted to electricity can be bought off the shelf.

4. Drawings

1) Aerofoil assembly with shaft
2) Structural frame work

5. User/client specifications

1) Cost effective
2) Easy to maintain
3) The device should not affect the motorists in any way (i.e. become a hazard)

6. Outcomes

A cost effective wind turbine that can either power a battery or power a highway light directly.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Snow/Ice Melting System for an Aeroplane Hanger

Lecturer, Ms NM Kotze
Max students, 5

Project Description

1. Background

SAA has it’s own maintenance crews that perform maintenance on commercial aeroplanes at OR Tambo. Maintenance takes place in the airplane hangers. These airplane hangers are extremely large and can accommodate most of the modern day Boeing and Airbus planes. Normally two to three commercial aeroplanes can be found in a hanger at a time undergoing maintenance.

2. Problem statement

Airplane hangers are extremely large with wide spans. The maintenance hangers at SAA have been structurally designed for standard South African conditions, namely above freezing point temperatures. However, there is a possibility of excess loading on the hanger roof due to ice/snow. This can cause structural deformation of the hanger.

3. Objectives of the design

Design a de-ice/snow system for an airplane hanger roof that can melt any ice/snow that may be on the roof. The design must include all the components of the system necessary to get the fluid to the roof, distribute it and recover the fluid and melted ice/snow to be reused. The heat exchanger as well as pipe supports and distribution mechanisms must all be a new design and their drawings included in the final report. The rest of the components of the system must be sized and can be bought off the shelf.

4. Drawings

1) Heat exchanger/s
2) Structural supports for exchangers
3) Pipe supports

5. User/client specifications

1) The hanger roof area is 400m x 100m and slightly inclined.
2) The hanger roof can a maximum layer of ice/snow of 10mm.
3) The system must be available at all times.
4) Due to the infrequent use of the system, a mechanism must be put in place to ensure that the system functional.
5) If the system can be used for other heating requirements (when not required for de-icing of the hanger), this would be advantageous.

6. Outcomes

Design a heating system that can be used to melt ice/snow on the roof of an inclined airplane hanger.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Hypothermia treatment device for pre-hospital settings

Lecturer, Ms NM Kotze
Max students, 4

Project Description

1. Background

Outdoor adventure sports is an abolute craze at the moment. More and more people want to excape the confines of the city and enjoy some time in "the wild", whether it be climbing a mountain, or hiking across the Savannah. It is in these situations, where the person is far removed from hospitals, that hypothermia becomes a deadly condition. The quicker you are able to treat a patient, the more favourable the outcome. “ACTIVE EXTERNAL WARMING” of the core is a preferred method.

2. Problem statement

Design a warming jacket suitable for warming hypothermic patients by rescue services in a pre hospital setting.

3. Objectives of the design

The design must include calculations and drawings of a compact heat exchanger to warm the working fluid, the warming jacket itself, all pipe work and connections as well as necessary components to circulate the working fluid. Weight and space restrictions must also be observed.

4. Drawings

1) Assembly and component drawings of active core heating device.
2) Assembly and component drawings of the auxiliary equipment used to heat the active core heating device.

5. User/client specifications

1) The device must be easy to use
2) The device must be reliable.
3) The device must be light enough to carry into remote areas.
4) The device must not harm the patient in any way.

6. Outcomes

A patient friendly warming device that can be used to minimise the hypothermic effect of a patient.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Dr G Mahmood

Design a thermocouple temperature boundary layer probe.

Lecturer, Dr G Mahmood
Max students, 3

Project Description

Thermal performance of heat exchangers and aero-thermodynamic performance of aerodynamic bodies are primarily dependent on the convection heat transfer coefficient on the body surface. To obtain estimations of the heat transfer coefficient experimentally, various intrusive and non-intrusive techniques of measurements are employed in simulated test environments. Some intrusive techniques include temperature measurement with surface thermocouples and heat-flux gages on the heated body. The most popular non-intrusive techniques of temperature measurement for the estimations of convection heat transfer coefficients are the infrared image thermography and liquid crystal thermography. However, these intrusive and non-intrusive measurements are difficult or impossible for the complex internal geometry of many heated bodies like pin-fins in channels, turbomachine blade surface, channel grooves, and jet cooling holes.
This project will design a thermocouple probe that will measure the temperature in the viscous sub-layer of the temperature boundary layer. The probe will be made of 20 micron thermocouple wires. Temperature in the viscous sub-layer can be extrapolated for the surface temperature. This type of probe can be employed in complex internal geometry as it measures the air temperature above the heated surface.

Special instructions: The design of probe may require some CFD analyses using the UP commercial softwares (Star CCM+ or Fluent).

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a two-component internal force balance for aerodynamic measurements.

Lecturer, Dr G Mahmood
Max students, 3

Project Description

Aerodynamic force and moments on laboratory models are measured in three ways: (i) surface pressure distributions, (ii) momentum balance around model control volume, and (iii) direct measurements of the force components and moments. The third method of direct measurements is simple and employs force balance with load cells either internally or externally. As the external force balance disrupts the flow over the test object of interest, internal force balance is many times the preferred method for force and moment measurements. Internal force balance is inserted into the object body and is connected to a sting arrangement that holds the object in the airstream. Typical load cells employed in the internal force balance are the foil strain gages. Coupled arrangements of strain gages in a two-component force balance can measure either the normal and axial forces or the normal force and pitching moment.
This project will design a two-component internal force balance that will measure the normal force and axial force on a model UAV wing built at UP. The two measured forces can be decomposed to obtain lift and drag on the wing, and determine the 3-D stall angle of the wing.

Special instructions: The design of force balance may require some FEA analyses using the Ansys software.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design an active turbulence grid for the UP Vane Cascade test facility.

Lecturer, Dr G Mahmood
Max students, 3

Project Description

The UP vane cascade is a test facility that simulates the turbine passage geometry employing 2-D blade profiles obtained from an actual GE engine. Tests are conducted for aerodynamic and heat transfer measurements with the aim of turbine passage modifications to increase the efficiency and durability of the gas turbine engines. As the turbulence is a critical flow parameter affecting the engine aero-thermal performance, the test facility needs some structural arrangements that can generate controllable low to high flow turbulence upstream of the vane-blade test section. This is known as the active turbulence grid. The project will design an active turbulence grid for the UP vane cascade employing an array of cylindrical rods. The rods will be given rotational speeds to generate periodic wakes that will eventually mix with the mean flow to produce turbulence. The design and speed of the rod arrangements are important as they will control the level of turbulence in the flow.

Special instructions: The design may need some CFD flow analyses using the commercial CFD softwares (either Star CCM+ or Fluent) at UP.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a small scale water tunnel for laboratory experiments.

Lecturer, Dr G Mahmood
Max students, 3

Project Description

Water tunnels are used for flow measurements and flow visualization on and over aerodynamic objects in the laboratory. The working fluid in tunnel is water. Because of high density of the water, a small flow rate in the tunnel provides a large Reynolds number for scaled laboratory models to be tested. This helps match the Reynolds number condition for the real prototype employed in practice. Flow visualization in many instances around the test object is easier with water than with the air. Water in the tunnel is pumped using a pump and dumped in sump after the test section of the tunnel. The pump then recirculates the water from the sump. A water tunnel thus usually works in a closed loop flow circuit.
The project will design a small scale low speed water tunnel that will be used for flow measurements and flow visualization. The pumping system for the tunnel must be part of the design.

Special instructions: The design may need some CFD flow analyses using the commercial CFD softwares (either Star CCM+ or Fluent) at UP.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a 3-D blade for axial-flow compressor using NACA airfoil.

Lecturer, Dr G Mahmood
Max students, 1

Project Description

Surge and stall due to flow separation from the blade surface in the axial-flow compressor affect the efficiency and operation. One of the primary reasons for flow separation from the blade surface is the blade airfoil shape and geometry. Asymmetric NACA airfoils have excellent aerodynamic performance and low drag coefficents which can be beneficial if employed in the compressor blade design.
The project will design a 3-D blade for an axial-flow compressor for superior aerodynamic performance and efficiency employing NACA airfoils. The design will be based on primarily the thermo-fluid analysis of the blade design.

Special instructions: The design will need some CFD flow analyses using the commercial CFD softwares (either Star CCM+ or Fluent) at UP.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a 3-D blade for axial-flow compressor using NACA airfoil.

Lecturer, Dr G Mahmood
Max students, 1

Project Description

Surge and stall due to flow separation from the blade surface in the axial-flow compressor affect the efficiency and operation. One of the primary reasons for flow separation from the blade surface is the blade airfoil shape and geometry. Asymmetric NACA airfoils have excellent aerodynamic performance and low drag coefficents which can be beneficial if employed in the compressor blade design.
The project will design a 3-D blade for an axial-flow compressor for superior aerodynamic performance and efficiency employing NACA airfoils. The design will be based on primarily the thermo-fluid analysis of the blade design.

Special instructions: The design will need some CFD flow analyses using the commercial CFD softwares (either Star CCM+ or Fluent) at UP.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mr RF Meeser

Wire straightener

Lecturer, Mr RF Meeser
Max students, 2

Project Description

Wire straightening and cutting is a critical part in the pre-processing of wire from the roll to desired form before it can proceed into various applications of mesh line welders. The wire straightening cutting machines are designed as modular lines to accommodate a range of wire straightening and cutting requirements, for the high speed production of straightened and cut wire. They are the first process the wire undergoes once leaving the roll.

It is required that a high speed, short interchange time (time to change set-up between wire diameter change) wire straightener for small diameter wire (less than 3mm) is to be designed. The wire straightener must operate with the principle of a track belt in order to apply the required tension in the wires thus stressing it into its plastic region of the material in order to straighten it.

Drawings of all of the components and the sub-assemblies are to be drawn up as well as an assembly drawing of the whole wire straighter.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

Phillip Pretorious

External Leader Location

Pietermaritzburg

External Organisation

Clifford welding systems

Helium dispenser

Lecturer, Mr RF Meeser
Max students, 3

Project Description

One of the most well known uses for Helium gas is to inflate balloons.
The goal of this design project is to design a device that will be able to, after actuation, deliver the correct amount of gas needed to inflate one balloon from the high pressure cylinder. This will save on costs for the gas as no over-filling and/or bursting of the balloons will take place.
Once the device has been designed a set of detail drawings of all the non-standard components is to be drawn as well as an assembly drawing of the entire device.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Zoom-able LED reflector

Lecturer, Mr RF Meeser
Max students, 3

Project Description

LED’s are quickly taking over the lighting market. These little components have the ability to produce over 1000 lumen from a chip 5mm in diameter.
The problem now is to effectively get the light from the LED to the object that needs to be lit up. The process of directing the beam of light is usually done with either a lens, or a reflector, with the focus of this project being on the reflector. Usually reflectors used for LED’s are of a fixed beam angle, so that focussing of the light using a reflector is not possible.
The goal of this design is to design a small reflector (around 13mm diameter) that is able to efficiently focus the light from a wide beam angle >30 degrees to a spot beam After the reflector has been designed a set of drawings showing the profile of the optimised reflector as well as the actuation mechanism for the changing zoom is to be made, as well as an assembly drawing of the whole design and the part assembly files given in as well.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Human powered plastic bottle shredder

Lecturer, Mr RF Meeser
Max students, 2

Project Description

Recycling is becoming an essential part of society as the rate at which land fills are filled is too high to sustain for a long time. A human powered plastic bottle shredder needs to be designed so that recycling in rural areas can be accomplished without the need for electrical power. For this project the student will design a shredding device that is power by a single human operator that enables the operator to shred plastic bottles so that the packing density for the recycling material is higher and more material can be transported.once the design is completed a set of detail drawings as well as assembly drawings for the bottle shredder need to be completed and handed in with the final report

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Prof JP Meyer

Mr L Page

Assistance Recumbent Tricycle

Lecturer, Mr L Page
Max students, 4

Project Description

1. Background
The assistance recumbent tricycle serves as a replacement for a traditional bicycle / tricycle in the life of an individual with an upper appendage disability. This product is capable of serving multiple functions for the user, as a means of transportation, rehabilitation and socialization with others. Currently, if a handicapped person wishes to participate in cycling, they must pay for an expensive custom-made prosthetic or have a customized tricycle made for them. These options are not widely accessible and can be prohibitively expensive

2. Problem statement
Design a general assistance recumbent tricycle for any user with an upper appendage handicap that prohibits any use of ones arms and hands.

3. Objectives of the design
The objective of this project is the completed design of a low cost assistance recumbent tricycle for users with an upper appendage disability.

4. Drawings
Detail drawings of all non standard parts that include sizing and finishes. Standard parts should be scientifically selected from local suppliers.

5. User/client specifications
The device should be easy to operate, install and maintain. The specifications given here need to be refined with the user/client. Safety and ergonomics while operating this tricycle must also be considered.

6. Outcomes
Detail drawings of all non standard parts that include sizing and finishes. Standard parts should be scientifically selected from local suppliers. A detailed manufacturing schedule, maintenance schedule and cost analysis should be included in the report. The report should be prepared and submitted as prescribed by the study guide.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Solar Powered Vehicle (Steering, Suspension and Braking)

Lecturer, Mr L Page
Max students, 3

Project Description

1. Background
With the depletion of fossil fuels becoming an ever growing concern, and the fact that the products of fossil fuels have a large contribution to pollution, alternative energy has become a highlighted area in research. Numerous companies have started developing alternative energy sources such biofuels, hydrogen, battery-electric vehicles, etc. South Africa has an abundance of sunlight and the Sasol Solar Challenge is and exciting, interactive example of how the benefits of the power of the sun can be reaped.

The Sasol Solar Challenge is a South African eco-efficiency challenge that aims to inspire teams from around the world to demonstrate the sophistication and performance of solar powered vehicles through leading technology. It is an exciting display of the power and flexibility of renewable energy in action through innovative designs. [www.sasolarchallenge.co.za]

2. Problem statement
This project is an integrated design project involving the teamwork of all the students working on this project to design a solar powered vehicle in accordance to the Sasol Solar Challenge and Fèdèration Internationale de l'Automobile (FIA) codes and regulations. For this project 7 students will be working on various design aspects of the solar powered vehicle. This aspect of the project includes the design of the steering and suspension systems as well as the specification of an adequate braking system.

3. Objectives of the design
Design the steering, suspension and braking systems using engineering principals for the challenger class solar vehicle. Integrate the design of the steering, suspension and braking systems with the other designed systems.

4. Drawings
Detail drawings of all non standard parts that include sizing and finishes. Standard parts should be scientifically selected and sourced first from local suppliers, where possible, before sourced from international suppliers.

5. User/client specifications
The design must adhere to the Sasol Solar Challenge and Fèdèration Internationale de l'Automobile (FIA) codes and regulations. Some of the requirements that should be taken into consideration, but not limited to, in the design are:
1) Vehicle performance (light weight and low rolling resistance)
2) Driver ergonomics (brake pedal and steering wheel)
3) Driver endurance (ride comfort)
4) Safety requirements

6. Outcomes
Detail drawings of all non standard parts that include sizing and finishes. Standard parts should be scientifically selected from local suppliers. A detailed manufacturing schedule and cost analysis should be included in the report. The report should be prepared and submitted as prescribed by the study guide.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Solar Powered Vehicle (Drive Train and Battery Box)

Lecturer, Mr L Page
Max students, 1

Project Description

1. Background
With the depletion of fossil fuels becoming an ever growing concern, and the fact that the products of fossil fuels have a large contribution to pollution, alternative energy has become a highlighted area in research. Numerous companies have started developing alternative energy sources such biofuels, hydrogen, battery-electric vehicles, etc. South Africa has an abundance of sunlight and the Sasol Solar Challenge is and exciting, interactive example of how the benefits of the power of the sun can be reaped.

The Sasol Solar Challenge is a South African eco-efficiency challenge that aims to inspire teams from around the world to demonstrate the sophistication and performance of solar powered vehicles through leading technology. It is an exciting display of the power and flexibility of renewable energy in action through innovative designs. [www.sasolarchallenge.co.za]

2. Problem statement
This project is an integrated design project involving the teamwork of all the students working on this project to design a solar powered vehicle in accordance to the Sasol Solar Challenge and Fèdèration Internationale de l'Automobile (FIA) codes and regulations. For this project 7 students will be working on various design aspects of the solar powered vehicle. This aspect of the project includes the design of the battery box and drive train system.

3. Objectives of the design
Design the battery box and drive train system using engineering principals for the challenger class solar vehicle. Integrate the design of the battery box and drive train system with the other designed systems.

4. Drawings
Detail drawings of all non standard parts that include sizing and finishes. Standard parts should be scientifically selected and sourced first from local suppliers, where possible, before sourced from international suppliers.

5. User/client specifications
The design must adhere to the Sasol Solar Challenge and Fèdèration Internationale de l'Automobile (FIA) codes and regulations. Some of the requirements that should be taken into consideration, but not limited to, in the design are:
1) Vehicle performance (light weight)
2) Energy efficiency
3) Ventilation (battery packs, motor)
4) Safety requirements

6. Outcomes
Detail drawings of all non standard parts that include sizing and finishes. Standard parts should be scientifically selected from local suppliers. A detailed manufacturing schedule and cost analysis should be included in the report. The report should be prepared and submitted as prescribed by the study guide.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Solar Powered Vehicle (Body and Wheel Fairing Aerodynamics)

Lecturer, Mr L Page
Max students, 2

Project Description

1. Background
With the depletion of fossil fuels becoming an ever growing concern, and the fact that the products of fossil fuels have a large contribution to pollution, alternative energy has become a highlighted area in research. Numerous companies have started developing alternative energy sources such biofuels, hydrogen, battery-electric vehicles, etc. South Africa has an abundance of sunlight and the Sasol Solar Challenge is and exciting, interactive example of how the benefits of the power of the sun can be reaped.

The Sasol Solar Challenge is a South African eco-efficiency challenge that aims to inspire teams from around the world to demonstrate the sophistication and performance of solar powered vehicles through leading technology. It is an exciting display of the power and flexibility of renewable energy in action through innovative designs. [www.sasolarchallenge.co.za]

2. Problem statement
This project is an integrated design project involving the teamwork of all the students working on this project to design a solar powered vehicle in accordance to the Sasol Solar Challenge and Fèdèration Internationale de l'Automobile (FIA) codes and regulations. For this project 7 students will be working on various design aspects of the solar powered vehicle. This aspect of the project includes the aerodynamic design of the body shape and wheel fairings.

3. Objectives of the design
Design the shape of the solar vehicle body and wheel fairings using aerodynamic principals for the challenger class solar vehicle. Integrate the design of the solar vehicle body and wheel fairings with the other designed systems.

4. Drawings
Detail drawings of all non standard parts that include sizing and finishes. Standard parts should be scientifically selected and sourced first from local suppliers, where possible, before sourced from international suppliers.

5. User/client specifications
The design must adhere to the Sasol Solar Challenge and Fèdèration Internationale de l'Automobile (FIA) codes and regulations. Some of the requirements that should be taken into consideration, but not limited to, in the design are:
1) Vehicle performance (low drag)
2) Driver vision and ergonomics
3) Safety requirements
4) Lights (head lights, brake lights, etc.)

6. Outcomes
Detail drawings of all non standard parts that include sizing and finishes. Standard parts should be scientifically selected from local suppliers. A detailed manufacturing schedule and cost analysis should be included in the report. The report should be prepared and submitted as prescribed by the study guide.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mr F Pietra

Windmill Water Pump.

Lecturer, Mr F Pietra
Max students, 2

Project Description

Short Description
Design a windmill water pump for domestic use.

1. Background
A windmill is one of the most energy efficient and ingenious ways ever devised to pump water from the ground. A windmill harnesses the free and renewable power of the wind and uses that energy to lift underground water to the surface for agricultural and other uses.
The power of the wind is captured and harnessed in two steps. Each step is easy to identify by simply observing a windmill in action.
First, notice how the fan turns. A windmill captures the energy of the wind with the large, circular fan, or "wheel", located at the top of the tower. When the wind blows, the fan rotates. Second, look just below the turning wheel and notice a long rod moving up and down. This "sucker rod", is powered by the windmill's motor. This motor is a unique set of mechanical gears that converts the rotary motion of the wheel into a reciprocating (up and down) motion that powers the cylinder pump located deep underground.
2. Problem Statement
Design a windmill water pump capable to extract water from a bore well.
3. Objectives of the design
The windmill has to be designed for domestic use. The design have to take under consideration the structure cost as well as the structure maintenance: both have to be as little as possible without compromising the structure safety.
4. Drawings
The windmill fan and the cylinder pump can be selected from catalogue according to the design specifications. All the mechanical parts in between have to be designed in details. Two selected mechanical components will be numerically evaluated by calculation or FEA.
5. User/client specifications
The required design is for a low cost windmill suitable for domestic use.
Pumping elevation: about 5 meters, windmill diameter: 2 – 3 meters.
It is supposed to be used in light to medium wind. For strong wind condition, the windmill will be disengaged: a manual device for stop the windmill has to be designed.
6. Outcomes
A drawing of the system that includes all the components and sizes. All components and sizes should be designed or selected according to the User/Client specification.
Specify the materials to be used and the manufacturing methods.
Perform a product cost estimate.
A report needs to be submitted as prescribed by the study guide.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Garbage bin automated side loader.

Lecturer, Mr F Pietra
Max students, 2

Project Description

1. Background
The “Side loaders” are trucks loaded from the side, either manually, or with the assistance of a joystick-controlled robotic arm with a claw, used to automatically lift and tip wheeled bins into the truck's hopper. An Automated Side Loader only needs one operator, where a traditional rear load garbage truck may require two or three people, and has the additional advantage of reducing on the job injuries due to repetitive heavy lifting.
2. Problem Statement
Design a robotic arm capable of grab a garbage bin, lift the bin over the truck and drop the content into the garbage truck. The robotic arm is on a side of the garbage truck.
3. Objectives of the design
Design the mechanism to unload the bin into the garbage truck. The mechanism has to be remotely operated by the truck driver. The objective of the design is the mechanism in order to automatically perform the unloading action: (a) grab the garbage bin, (b) lift the bin over the truck, (c) unload the bin.
4. Drawings
The garbage truck, the control joystick and the controlling electronic are not part of the design. All the other mechanical parts of the side loader system have to be designed. Two selected mechanical components will be numerically evaluated by hand calculation or FEA.
5. User/client specifications
The mechanism has to be capable of handling a standard garbage bin full of standard domestic garbage. The design has to carefully consider safety and durability aspects.
6. Outcomes
A drawing of the system that includes all the components and sizes. All components and sizes should be designed or selected according to the User/Client specification.
Specify the materials to be used and the manufacturing methods.
Perform a product cost estimate.
A report needs to be submitted as prescribed by the study guide.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Variable pitch blade propeller for model aircraft.

Lecturer, Mr F Pietra
Max students, 2

Project Description

1. Background
A variable pitch propeller is a type of propeller with blades that can be rotated around their longitudinal axis to change their pitch. If the pitch can be set to negative values, the reversible propeller can also create reverse thrust for braking or going backwards without the need of changing the direction of shaft revolutions.
Normally the radio-controlled (model) airplanes have the possibility to adjust the blade pitch on the ground so, during the flight, the blade pitch is constant. In order to increase the performance of the propeller, a variable pitch propeller could be used.
2. Problem Statement
Design the mechanism to rotate the blades of a propeller around their longitudinal axis (variable pitch blades), during the flight. The propeller is used to power a scale airplane.
3. Objectives of the design
Design the mechanism to change the pitch of the propeller blades during inflight condition. The mechanism will be controlled by the operator on the ground using a radio transmitter.
4. Drawings
The radio transmitter and the electronic part of the mechanism are not part of the design. All the other mechanical parts of the variable pitch blade propeller have to be designed. Two selected mechanical components will be numerically evaluated by hand calculation or FEA.
5. User/client specifications
The mechanism has to be fitted into a 60-size scale plane. The control mechanism has to be capable of changing the blade pitch from +60 degree (pull position) to -30 degree (reverse position).
6. Outcomes
A drawing of the system that includes all the components and sizes. All components and sizes should be designed or selected according to the User/Client specification.
Specify the materials to be used and the manufacturing methods.
Perform a product cost estimate.
A report needs to be submitted as prescribed by the study guide.

Category

Aeronautical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Pantograph for city tram.

Lecturer, Mr F Pietra
Max students, 2

Project Description

1. Background
A pantograph is an apparatus mounted on the roof of an electric train or tram to collect power through contact with an overhead catenary wire. It is a common type of current collector. The term stems from the resemblance of some styles to the mechanical pantographs used for copying handwriting and drawings.
Typically, a single wire is used, with the return current running through the track. As the train moves, the contact shoe slides along the wire collecting the electricity needed to run the train.
2. Problem Statement
Design a pantograph for an urban tram system. The design has to be capable to guarantee the contact between the catenary wire system during the normal operation (acceleration and brake, change of direction, different catenary height, etc.).
3. Objectives of the design
Design a pantograph mechanism to connect an electric tram to the power line (overhead catenary wire). The mechanism has to be remotely operated by the tram driver. The mechanism has to guarantee high level of safety and reliability.
4. Drawings
The tram carriage and the catenary wire structure are not part of the design. All the other mechanical parts of the pantograph have to be designed. Two selected mechanical components will be numerically evaluated by hand calculation or FEA.
5. User/client specifications
The pantograph has to be fitted in a modern tram carriage for urban public transport. The tram carriage will be selected from an international producer.
6. Outcomes
A drawing of the system that includes all the components and sizes. All components and sizes should be designed or selected according to the User/Client specification.
Specify the materials to be used and the manufacturing methods.
Perform a product cost estimate.
A report needs to be submitted as prescribed by the study guide.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Steadicam for GoPro camera.

Lecturer, Mr F Pietra
Max students, 2

Project Description

Short Description
Design a mechanism that mechanically isolates the GoPro camera from the operator's movement.

1. Background
The ‘steadicam’ is a camera stabilizer mount for motion picture cameras that mechanically isolates it from the operator's movement. It allows for a smooth shot, even when moving quickly over an uneven surface.
A steadicam essentially combines the stabilized steady footage of a conventional tripod mount with the fluid motion of a dolly shot and the flexibility of hand-held camera work. While smoothly following the operator's broad movements, the steadicam's armature absorbs jerks, bumps, and shakes.
2. Problem Statement
Design a steadicam mechanism for the GoPro camera.
3. Objectives of the design
Design a mechanism capable of isolate the GoPro camera from the operator’s movement in order to guarantee a better stability in the shots. The GoPro is normally used to shot sport activities: the design has to consider the particular use of the camera.
4. Drawings
All your design’s drawing are requested. Two selected mechanical components will be numerically evaluated by hand calculation or FEA.
5. User/client specifications
The mechanism has to be as light as possible and don’t interfere with the sport practice. The mechanism has to fit a wide range of users and has to be used in a wide range of sports. The design has to be as cheap as possible.
6. Outcomes
A drawing of the system that includes all the components and sizes. All components and sizes should be designed or selected according to the User/Client specification.
Specify the materials to be used and the manufacturing methods.
Perform a product cost estimate.
A report needs to be submitted as prescribed by the study guide.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Gimbal for GoPro camera.

Lecturer, Mr F Pietra
Max students, 2

Project Description

Short Description
Design a mechanism capable of connects a GoPro camera to a quadcopter and rotate the camera during the flight.

1. Background
A gimbal is a pivoted support that allows the rotation of an object about a single axis. In the aerial photography a camera gimbals is normally used to isolate the camera from the vehicle vibrations and to maintain the balance during the flight operation. In particular, when quadcopter is flying, in order to maintain balance either automatically or manually, the motors changes speed to adjust roll/pitch/yaw angles. Therefore even with the best balanced aircraft, you will still see some level of shakiness in your video. By using a cemera gimbal, it compensates the change of roll/pitch angle, and leaves the camera steady so you have perfect images.
2. Problem Statement
Design a gimbal mechanism to connect the GoPro camera to a quadcopter.
3. Objectives of the design
Design the gimbal mechanism. The gimbal has to be capable of isolate the camera from the flight vibration and to rotate the camera 360 degree in the flight plane, and 180 degree in the plane perpendicular to the flight plane.
The mechanism has to be independent from the quadcopter but for the power. The power is supplied by the quadcopter batteries.
4. Drawings
The quadcopter, the GoPro camera and the controlling electronic are not part of the design. All the other mechanical parts of the gimbal have to be designed. Two selected mechanical components will be numerically evaluated by hand calculation or FEA.
5. User/client specifications
The mechanism has to be capable of rotating a GoPro camera 360 degree in the flight plane and 180 degree in the plane perpendicular to the flight plane. The design has to be capable of reducing the vibration induced by the quadcopter. The design has to be as light as possible.
6. Outcomes
A drawing of the system that includes all the components and sizes. All components and sizes should be designed or selected according to the User/Client specification.
Specify the materials to be used and the manufacturing methods.
Perform a product cost estimate.
A report needs to be submitted as prescribed by the study guide.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mr S Roux

Portable “donkey”-braai

Lecturer, Mr S Roux
Max students, 4

Project Description

1. Background
Braaing is one of the standard activities on a camping trip but, oftentimes, so are cold showers. Fires for braaing produces more heat than is used therefore the excess heat can be used to heat up a “donkey”.

2. Problem statement
Design a portable braai that incorporates a “donkey”.

3. Objectives of the design
A complete heat transfer analysis of the system should be performed as well as the necessary structural calculations.

4. Drawings
Drawings will be required of all non-standard individual components and the complete assembly.

5. User/client specifications
The donkey must be able to heat water at a rate of 6 kW, must be easily detached from the braai and must incorporate the necessary safety precautions. The braai must be able to accommodate 50L, 100L and 150L drums.

6. Outcomes
The design must incorporate all information required for building and assembly.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Lift system for the wind tunnel labs

Lecturer, Mr S Roux
Max students, 3

Project Description

1. Background
The wind tunnel labs currently have no disability access and transport of goods to and from the labs is often troublesome.

2. Problem statement
A lift system is required to address the present shortcomings.

3. Objectives of the design
The complete design of a lift system that is easily accommodated by the current lab staircase.

4. Drawings
Drawings will be required of all non-standard individual components and the complete assembly.

5. User/client specifications
The lift must be able to carry a working load of up to 500kg.
All applicable safety standards must be adhered to.

6. Outcomes
The design must incorporate all information required for building and assembly.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Three-axis traverse system for the closed-circuit wind tunnel

Lecturer, Mr S Roux
Max students, 3

Project Description

1. Background
The closed-circuit wind tunnel is currently shy a three-axis traverse system.

2. Problem statement
Design a three-axis traverse system for the closed-circuit wind tunnel.

3. Objectives of the design
The design should have the flexibility to be used with various measurement apparatus and with the ability to be fully automated at a later stage.

4. Drawings
Drawings will be required of all non-standard individual components and the complete assembly.

5. User/client specifications
The traverse system must be of such a nature that it will be able to be manufactured in the university workshops and must be able to be operated manually or by means of stepper motors.

6. Outcomes
The design must incorporate all information required for building and assembly.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Dr M Sharifpur

Modifying one of the Steam Power Plants of South Africa by using Boiling Condenser (BC)

Lecturer, Dr M Sharifpur
Max students, 4

Project Description

One of the most important problems in the steam power plants is to increase the thermal efficiency of the cycle. Most of the researches in this area are focused on regeneration devices, removing the heat losses from components etc. Usually, more than half of the input energy in the thermal cycle wastes in the condensers. One of the ways to increase the thermal efficiency is to use boiling condenser (BC) in steam power planets. In the boiling condenser the vapor of the working fluid can enter another turbine in a new cycle. According to property, the design features, and BC's new cycle, it is possible to convert some unused energy to work which has more compatibility with environment as well. In this design a modification for an available steam power plant of South Africa will be done using BC. This design has the capability to publish a paper in an international conference if the student offers a proper work. However, you should have a strong background in thermodynamics and you also need to know how to program in EES software.
You should read the study guide of the course carefully and your final report should include the following:

• Cover sheet
• Abstract
• Introduction
• Literature review
• Concept generation for modification
• Choosing a concept for maximum efficiency
• Model development, analysis and calculations
• Structural Designing, Drawings and Manufacturing for some of the parts
• Optimization
• Environmental impact
• Discussions
• Conclusion

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Designing an Exhaust Gas Energy Converter (EGEC)

Lecturer, Dr M Sharifpur
Max students, 3

Project Description

Usually a significant amount of energy wastes in the exhaust gases of automobiles, ships, gas-turbine power plants.... It can convert some parts of this waste energy to work by using a proper working fluid in an exact thermodynamics cycle. The cycle could operate between the exhaust gas temperature and the environment temperature. Therefore, the Exhaust Gas Energy Converter (EGEC) is a smart thermodynamics cycle with a proper working fluid in order to convert some fractions of the waste heat of a high temperature exhaust gas to work. It includes boiling heat exchanger, turbine, condenser and a pump with a smart control system. In this design the work must be done for an exhaust gas which wasting energy in South Africa (car, power plant, industry…). This design has the capability to publish a paper in an international conference if the student offers a proper work. However, you should have a strong background in thermodynamics and heat transfer, and you also need to know how to program in EES software.
You should read the study guide of the course carefully and your final report should include the following:

• Cover sheet
• Abstract
• Introduction
• Literature review
• Choosing a target exhaust gas
• Concept generation
• Choosing a concept for maximum efficiency
• Model development, analysis and calculations
• Structural Designing, Drawings and Manufacturing for one of the parts
• Optimization
• Environmental impact
• Discussions
• Conclusion

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Designing a Boiling Condenser (BC) for a Typical Steam Power Plant of SA

Lecturer, Dr M Sharifpur
Max students, 3

Project Description

Boiling condenser (BC) is a new design heat exchanger that could be replaced with typical condensers of a steam power plant in order to increase the power plant efficiency. A boiling condense (BC) consists of some vertical channels which include parallel vertical tube bundles. Steam from the power plant turbine exit could enter to the tube bundles of the BC. Outside of the tube bundles (between tube bundle and the channel) are almost filled of a proper subcooled working fluid. Therefore, while the condensation happens inside the tubes (for steam), boiling occurs outside of the tube bundles for the working fluid which we can send it to BC thermodynamic cycle (including turbine and condenser). In this design the data of an available thermal power plant of South Africa must be used. This design has the capability to publish a paper in an international conference if the student offers a proper work. However, you should have a strong background of thermodynamics and also you need to improve your knowledge in design software.
You should offer some progressing reports and your final report should contain the following:
• Cover sheet
• Abstract
• Introduction
• Literature review
• Model development, analysis and calculations
• Optimization
• Drawings
• Discussions
• Conclusions

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Prof JFM Slabber

Development of a radiation beam stop for a neutron radiography facility

Lecturer, Prof JFM Slabber
Max students, 1

Project Description

Background:
The Radiography/Tomography section of the Radiation Science Department at Necsa has the vision to establish the Southern African Nuclear Centre for Radiography and Tomography at Necsa as part of the Beam line Center to fulfil the needs of the research community.
Infrastructure to this Centre entails a Micro-focus X-ray tomography (Currently operational) facility, a Neutron tomography (Currently in an upgrade phase to state of the art equipment) facility and an envisaged Gamma-Ray tomography facility (Planning phase).
The Neutron radiography facility is one of the 3 beam line facilities on the beam port floor of the SAFARI-1 nuclear research reactor. In the worst case scenario, a 300mm diameter radiation beam (White Spectrum) emanating from the core of the reactor, is being utilised for the purpose of non-destructive examination and investigation of research and laboratory scale samples. Most of this radiation beam (containing all neutron and gamma-ray energies) is travelling through the sample and detector and needs to be stopped completely by a radiation trap.

Problem Statement:
The Neutron radiography facility is currently in an upgrade phase. The proposed plans for the experimental chamber are shown in Figure 1 below.

A simulation of the radiation dose rates was done to investigate the radiation distribution in and around the experimental chamber. Figure 2 shows the expected neutron dose rate while Figure 3 shows the expected gamma dose rate. It can be seen on these figures that extra shielding is necessary at the end section of the experimental chamber, as some neutron and gamma radiation levels are detectable outside the experimental chamber which are above the acceptable radiation levels.

Figure 2: Neutron dose rate in experimental chamber

Figure 3: Gamma dose rate in experimental chamber

An enlarged view of the end section is shown in Figure 4. An additional radiation beam stop section is to be designed which will be installed in this area.

Figure 4: End section of experimental chamber
The design challenges of such a radiation trap/stop are:
• Minimize the generation of secondary radiation upon neutron absorption,
• Minimize the generation of scattered radiation (Primary and secondary) inside the experimental chamber that will have effectively a detrimental effect on quantitative tomography results,
• Reduce the radiation dose, as part of the biological shield of experimental chamber, at the outside of the shielding to an acceptable radiological level and
• Installed within predefined geometrical constraints

Design Proposal
The radiation trap will comprise of multiple materials. A detailed materials and composites investigation will be completed. The material requirements will be dominated by the following important objectives:
• Suitable shielding of gamma rays
• Material with large scattering cross section for the decrease of neutron energies
• Material with large absorption cross section for the shielding of neutrons

The above mentioned phenomenon causes an increase in material temperature due to energy deposition during the scattering and absorption reactions. Therefore the temperature distribution within the radiation trap section will also be investigated.
The final outcome of the design project will be material specifications and design drawings which will meet the radiation trap requirements for the Necsa Neutron radiography facility.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

NECSA

Ms L Smith

Design of a testing and launch device for the AREND UAV

Lecturer, Ms L Smith
Max students, 2

Project Description

Team AREND will design a technological solution to aid Kruger National Park (KNP) rangers in the protection of black and white rhinos from poaching. The solution shall constitute, but not be limited to, an unmanned aircraft (18kg, 4.5m wingspan, cruise speed 20m/s, stall speed 15m/s) capable of conducting remote surveillance of large park areas such as KNP. The UAV shall be operable from a central base within KNP, have extended flight endurance (~120 min), and be able to detect/distinguish humans and animals with onboard sensors.

The final deliverable of this project shall be an aircraft test flight to demonstrate flight worthiness and provide a validation document. Initial flight tests are done using a RC controller but the intention is that the aircraft will later fly autonomously. Within this context team AREND requires a launch device that can ideally also act as a flight testing device. The UAV is designed without a dedicated undercarriage and therefore requires a device to assist in the runway launch process.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of foldable wings to improve lift

Lecturer, Ms L Smith
Max students, 2

Project Description

In order to reduce emissions in air transportation the Subsonic Ultra Green Aircraft Research (SUGAR) program designed the innovative SUGAR Volt which is driven by an electric battery gas turbine hybrid propulsion system that can reduce overall fuel usage by 70%.

Adding to its energy-efficiency, the SUGAR Volt’s wings would stretch to almost double the length of traditional aircraft, allowing for greater lift and shorter take-off and landing times. In order to accommodate existing airports, the long wings will fold when landed and enable the plane to taxi and park at the airport gate safely.

Using the specifications of the SUGAR Volt, redesign the foldable wings for subsonic flow (M

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Long endurance solar powered UAV design

Lecturer, Ms L Smith
Max students, 2

Project Description

Solar powered aircraft are becoming more and more interesting for future long endurance missions at high altitudes, because they could provide Earth monitoring, telecommunications, etc. without any atmospheric pollution and, hopefully in the near future, with competitive costs compared with satellites. Earth monitoring can be used to prevent animal poaching in the National parks in South Africa and can there for be of great benefit to conservation.

Conceive and design a remote-piloted aircraft equipped with distinct sensors, embedded systems and 3G/4G and TCIP communications in a robust and high endurance aircraft.

The UAV should comply with the following criteria:
Maximum weight: Endurance: 120 minutes
Range: 20 -60 km
Altitude: 60 - 120m

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Investigation and design surrounding oblique wings: swing wing design

Lecturer, Ms L Smith
Max students, 2

Project Description

Variable sweep wings allow an aircraft to take advantage of the lift and handling qualities of a straight wing during slow flight of take offs and landings and the reduced drag and the better efficiency of swept back wings during cruise. Investigate the concept of an oblique (or pivoting) wing.

Consider the aerodynamic forces experiences by the aircraft at a Mach number range of 0.5 - 1.5. Design the pivoting mechanism using the oblique wing profile to allow the wing to rotate on its center pivot so it could be at the most efficient angle for a specific speed.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Redesign of a small scale wind turbine for wind tunnel testing purposes

Lecturer, Ms L Smith
Max students, 2

Project Description

Turbines in series have an inherent loss of power due to turbulent winds generated from upwind turbines. In order to investigate the layout of a wind farm using three successive turbines to find the optimal setup in terms of horizontal layout and height a wind tunnel set up has been built. However the wind turbine blades are experiencing aerodynamic stall due to the manufacturing techniques used.

Design a turbine hub to fit into a representative Vestas type fairing supported on rolling element bearings able to support the torsional and axial (thrust loading). Re-mount the existing 3D printed blades on this hub to allow for a statically adjustable variable pitch. Design a tower for the model to support the windturbine and to withstand the bending moments induced by the wind.
Utilize the BEM (Beam element method) to evaluate the windturbine model performance at different reprenterntative wind conditions.

To obtain a windturbine model that has low torque, is statically adjustable (different blade pitch angles) and is both reasonable accurate and rugged. Both manufacturing and assembly drawings are required in order to achieve the goals stated above. A design for a windturbine model as described above which is cheaply and accurately manufacturable.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

Gerhard Benade

External Leader Location

N/A

External Organisation

N/A

Prof NJ Theron

Design of a mechanical synchronization system for multiple generator sets

Lecturer, Prof NJ Theron
Max students, 4

Project Description

1. Background
In conditions where power cuts due to load shedding or other supply uncertainties are prevalent of even merely possible, many organizations and even home owners turn to the installation of backup generators. Small scale power generation may be made more efficient with the ability to run individual generators near maximum efficiency and switching on additional generators as demand varies. When two AC generators are to be connected, while running, to the same electrical grid, the generated AC voltage needs to be synchronized before the connection is established. This is normally done using power electronics. It can however also be done using a differential gearbox with an angular position controlled actuator.

2. Problem statement
Design an automatic computer/electronic controlled differential gearbox based synchronization system for connecting a single 10kVA generator to a grid and compare the cost of the design with that of available off-the-shelf power electronics technology.

3. Objectives of the design
To design a cost effective mechanical synchronization system for the connection of small backup generators into a single grid.

4. Drawings
There is sufficient scope in this design to meet the departmental requirements for drawings.

5. User/client specifications
User/client specifications: The designer must compile the specifications in detail.

6. Outcomes
A workable design meeting the specifications

6. Outcomes

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Manifold to connect water pumps to large diameter pipe

Lecturer, Prof NJ Theron
Max students, 5

Project Description

1. Background
Rand Water is the largest water utility in Africa, supplying 4,4 megalitre fresh drinking water per day to 12 million people. This organization operates a total pipeline length of 3300 km with the largest diameter currently in use 3,5 m. Thin walled rib-stiffened steel pipes of 4 m diameter is now considered for use. Such a large diameter pipe is never fed by a single pump, but by a number of pumps in a pumping station.

2. Problem statement
Design a steel manifold system to connect the outlet of 10 centrifugal pumps to a 4 m diameter thin walled high pressure pipeline.

3. Objectives of the design
To provide an effective, in terms of both capital and operating costs, and reliable system for connecting a number of centrifugal pumps in a pumping station to a single very large diameter pipeline.

4. Drawings
There is sufficient scope in this design to meet the departmental requirements for drawings.

5. User/client specifications
The designer must compile the specifications in detail. Among others, the manifold should be able to withstand the static test pressure that Rand Water uses in testing its pipelines, which is considerably more than the larges operating pressure.

6. Outcomes
A workable design meeting the specifications

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Automated polyurethane mixer/dispenser

Lecturer, Prof NJ Theron
Max students, 1

Project Description

1. Background
This design project will be to create a dispenser that will be able to supply liquid polyurethane at a user specified mixing ratio and temperature. Currently the polymer is mixed with hand held electric tools and the output rate of products is extremely low. This project will design a system that can significantly increase the production rate and at the same time improve the quality of the product.

The product will be designed so that it can be manufactured at a later stage to be used in a factory to allow a greater manufacturing rate.

The company for whom this design is done specialises in the design and development of a wide range of airless tyres, from 20 kg forklift tyres to 400 kg underground mining vehicle tyres.

2. Problem statement
The process plant needs to be designed to fit within a volume of 2mx2mx2m. The plant needs to produce polyurethanes with a mixing ratio inaccuracy below 5%. This is applicable for creating parts from 20 to 500 kg. The plant must be able to accommodate any polyurethane that requires a pre-polymer and a curative. The system must be designed in such a way as to allow the operator to select the polymer grade he is using, the curative ratio he requires and the part size that is being cast. The plant must then automatically bring all the material s to their relevant temperatures and then mix and dispense the polyurethane into an awaiting mould.

The plant must be able to dispense 500kg of polymer under 5 minutes as this will be the maximum size part that will be created with this system. The polymer begins to “jel” i.e increase its viscosity, after 8 to 10 minutes, depending on numerous factors such as the curative ratio, cast temperature and grade of polyurethane. This is why it is important for the system to dispense all the material before the material sets as the components such as the pumps and piping will need to be scrapped if the polyurethane sets inside them. A cleaning system needs to be developed that flushes the system directly after a casting has occurred. This will be done by pumping a chemical that stops the reaction from completing. The plant needs to be easily maintainable so that there is minimum down time if a key component fails unexpectedly.

3. Objectives of the design
The aim is to design a semi-autonomous polyurethane dispensing plant that is cheap, accurate, easy to operate and easily maintainable.

4. Drawings
There is sufficient scope in this design to meet the departmental requirements for drawings.

5. User/client specifications
The designer must compile the specifications in detail.

6. Outcomes
a.) Schematic of plant and all related systems
b.) Detailed CAD design of plant
c.) Pump sizing calculations
d.) Heat transfer calculations for oil heat exchanger
e.) Control System design
f.) Manufacturing drawings of all unique components
g.) Pressure vessel design for pre polymer tank
h.) Heat transfer analysis for pre polymer tank
i.) Flow rate calculations for all grades of polymers at all curative ratios
j.)Structural analysis of plant housing structure
k.) Cost analysis of complete system including manufacturing cost for unique components
l.)Design or selection of design for the polyurethane mixing chamber

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

Rockon non-Pneumatic Tyres (Pty) Ltd

Dr C Thiart

Labyrinth seal analyses

Lecturer, Dr C Thiart
Max students, 5

Project Description

1. Background
Labyrinth seals are non contacting high pressure seals that seal off rotating shafts like in turbines. Although this sealing technology is well established, there are certain shortcomings. New labyrinth concepts are constantly under developement.

2. Problem statement
There is a need to improve the analysis of this sealing technology. This includes verification of present theory and experiements. New concepts are also analysed.

3. Objectives of the design
The student must design and simulate and analise a laberinth seal for specific conditions. The student wil have to do analytical calculations and CFD simulations.

4. Drawings
The drawings will reflect the improvement suggestions of the study

5. User/client specifications
The design will be evaluated against modern commercial products.

6. Outcomes
Proper understanding of the principles associated with laberinth sealing, possible improvement areas and detail suggestions

Category

Aeronautical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Windsurfer sail and mast design

Lecturer, Dr C Thiart
Max students, 2

Project Description

1. Background
Windsurfer performance is highly influenced be the sail dynamics. Sail performance is determined by lift and drag considerations. The drag is also influenced by the structural dynamics of the sail and mast.

2. Problem statement
There is a need to improve on this technology in an attempt to break the world speed record

3. Objectives of the design
Design a windsurfer sail and mast to be used for speedsailing in 30+knots of wind. The sail area is 6 square meter. CFD analyses and/or structural analyses will be required.

4. Drawings
The drawings will reflect the improvement suggestions of the study

5. User/client specifications
The design will be evaluated against modern commercial products.

6. Outcomes
Proper understanding of the principles associated with high speed sail behaviour, possible improvement areas and detail suggestions

Category

Aeronautical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design windsurfer board for speedrecords

Lecturer, Dr C Thiart
Max students, 3

Project Description

1. Background
Windsurfer performance is highly influenced be the board design

2. Problem statement
Windsurfer board design keeps on changing in an ettempt to improve on the world record.

3. Objectives of the design
Design and analise a windsurfer board to be used for speedsailing in 30+knots of wind. CFD analyses will be required to compare different designs

4. Drawings
The drawings will reflect the improvement suggestions of the study

5. User/client specifications
The design will be evaluated against modern commercial products.

6. Outcomes
Proper understanding of the principles associated with high speed board behaviour, possible improvement areas and detail suggestions

Category

Aeronautical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Dr N Wilke

Design low cost home coffee roaster

Lecturer, Dr N Wilke
Max students, 3

Project Description

1. Background

Coffee is the second largest legally traded commodity after oil. Africa is a large producer of coffee in the world market.

2. Problem statement

Professional coffee roasting equipment easily exceeds R 100k and allows for large batches of coffee to be roasted. Design a low cost coffee roaster that could be used to roast small batches of coffee for home use max 2 kg of green beans.

3. Objectives of the design

Low cost compared to current home roasters on the market for similar batch sizes.
Design aim to increase the uniformity of the roasting. The design must allow for variable heat input. The roaster must be easy to maintain and use inside a house.

4. Drawings
Drawings as specified in the study guide. Specific drawings will be identified during the project by the study leader.

5. User/client specifications
Roast maximum of 2kg of green beans uniformly.

6. Outcomes
The complete design of the roaster that is easy to maintain and assemble from manufactured and/or standard components. A report needs to be submitted as prescribed by the study guide.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a 3D printer filament extruder

Lecturer, Dr N Wilke
Max students, 4

Project Description

1. Background

Fused deposition modeling is one of the 3D printing technologies that is rapidly taking the manufacturing, medical and culinary world by storm. One of the benefits of 3D printing is it's focus on recyclability, in particular when plastics are involved.

2. Problem statement

Design a filament extruder that allows for the recycling of granulated PLA and ABS by extruding and spooling the filament so that it can be used to print on a coneventional FDM 3D printer.

3. Objectives of the design
Design a PLA / ABS filament extruder from granulated material that also allows for the spooling of the filament as it is extruded. The system must be able to extrude at a constant temperature.

4. Drawings
Drawings as specified in the study guide. Specific drawings will be identified during the project by the study leader.

5. User/client specifications
The input materials are PLA and ABS plastics. The temperature settings can be set to stay constant at any temperature between 40°C to 230°C. The extrude rate must be able to vary from 25 cm\min to 50 cm\min.
Interchangable nozzle diameters from 1.75mm - 3.00mm.

6. Outcomes
The complete design of the extruder that is easy to maintain and assemble from manufactured and/or standard components. The extruder can be controlled by an Arduino system that you do not have to develop. A report needs to be submitted as prescribed by the study guide.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mobile device to enable wheelchair users to use small airports

Lecturer, Dr N Wilke
Max students, 3

Project Description

1. Background
Small airports often lack the infrastructure to accommodate wheelchair users to travel from these destinations.

2. Problem statement
Wheelchair users have a hard time traveling from small airports due to a lack of infrastructure to accommodate wheelchair users.

3. Objectives of the design
Design a mobile device that will facilitate the loading and unloading of wheelchair users onto various aircrafts that operate from small airports.

4. Drawings
Drawings as specified in the study guide and will be specified during the course of the project.

5. User/client specifications
The device should be easy to operate, install and maintain. The device must be adjustable for various aircrafts either loading the passenger with the wheelchair or enabling the wheelchair user to transfer seats into the aircraft.

6. Outcomes
Design the structure and powering of the system using manufacutred and / or standard components. A report needs to be submitted as prescribed by the study guide.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Dr B Xing

Miniature robot design and analysis for in-pipe inspection

Lecturer, Dr B Xing
Max students, 10

Project Description

1. Background

The electric power system, as the main energy source supply to other infrastructure, stands central and is essential to the operation of all other systems. Nowadays the electric utilities are confronted with many challenges in this new era of competition, such as load forecasting, unit commitment, economic load dispatch, maintenance of system frequency and declared voltage levels as well as interchanges among the interconnected systems in power pools. As a consequence, modern power systems are increasingly vulnerable to cascading failures in which a small series of events can lead to a major blackout. Eskom uses various technologies to generate electricity, the combination of which is called the 'plant mix'. The utility is constantly investigating other forms of energy and renewable energy sources that could be used to expand its current plant mix and has initiated various research projects looking at wind, solar, tidal, wave and biomass sources of energy. Nevertheless, with the rapid expansion of Eskom's power plant mix, the maintainability of these power plants becomes a crucial issue confronting the practitioners. During the past four decades, the key areas that have influenced maintenance are management of personnel and assets, and technological capability. These areas are important because they aim to take the best advantage of expensive resources, whether that advantage is profit, or to provide the best possible service with limited resources.

The miniature robot for inspection research intends to exploit the e-maintenance strategy. Among others, the information and communication technology (ICT) allows us to identify building blocks for the design of a swarm of miniature robots.

• First, the use of miniaturized devices which has dramatically increased the ways of data can be acquired.
• Second, the extension of communication technologies (from fixed telecommunication networks to high speed mobile telecommunication networks) which has ultimately boosted the usage of the Internet as a main distributed platform for business operation.

2. Problem statement

• The main research question addressed by this proposal is e-maintenance.
• The second research question addressed by this proposal is miniature robot design and analysis.

3. Objectives of the design

Although this idea (miniature robot for machinery condition inspection) is intellectually appealing and could pave the way for other similar applications in the inspection of potentially complex, engineered or natural structures, it involves a series of technical challenges that drastically limit possible designs of robotic sensors and can loosely be classified into three engineering thrusts: miniaturization of sensors and actuators, control of distributed hybrid systems, and sensor fusion for providing information to a human operator or an expert system. The distributed system can be considered hybrid in the sense as that the individual robotic platform is controlled by a series of reactive continuous control laws, which are switched by some logic function or algorithm.

4. Drawings

A set of drawings of the designed test bench should be submitted as prescribed by the study guide for MOX410.

5. User/client specifications

Different miniature robot designs and the corresponding analysis, e.g., for pipe inspection, for turbine inspection, for transmission line, for complex indoor environment, etc.

6. Outcomes

A set of drawings of the designed test bench should be submitted as well as a report as prescribed by the study guide for MOX410.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mr J Huyssen

Design of a water ballast dump valve for sailplanes

Lecturer, Mr J Huyssen
Max students, 2

Project Description

1. Background
On some sailplanes the wing volume is not sufficient to hold all the water ballast and a significant amount may need to be held in a fuselage tank. This can lead to structural overloading of the wing in gusty conditions.
2. Problem statement
A dump valve is required which would dump the water from the fuselage tank before the wing stresses exceed a critical level.
3. Objectives of the design
Determine under which flight condition dumping would be required and at what rate water must then be dumped.
4. Drawings
Concept drawings of different dump valve concepts
A solid model of the valve assembly
Detail drawings of the main valve components
5. User/client specifications
The fuselage tank can hold 100 l of water
The valve can be opened by the pilot to dump up to 180 l/min of water
The valve will open automatically in high load conditions to dump the content as recommended
The valve shall be re-sealable after an emergency discharge (after the flight)
Flight properties of the aircraft shall not be effected by the valve
6. Outcomes
The detail design of a dump valve which can be installed onto a seat tank of a sailplane.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a pilot seat ballast tank for a sailplane

Lecturer, Mr J Huyssen
Max students, 2

Project Description

1. Background
A two-seat ultra-light glider under development shall be operated at a very high wing loading when carrying water ballast in wing and fuselage tanks. To compensate for an absent passenger or a very light pilot and or passenger the seats of the glider are to be made as water ballast tanks so that the glider can be operated at maximum wing loading regardless of the occupant mass.
2. Problem statement
The centre of gravity (CG) of the glider needs to remain in the same location with the tanks filled to any capacity. The ballast needs to be dumped rapidly in the event of an emergency. The seats form part of the occupant protection system.
3. Objectives of the design
Design an ergonomic pilot seat in which the CG centered ballast tank is integrated. Ensure that the seat can act as and energy absorber and that it will protect against foreign object penetration in the event of a crash landing.
4. Drawings
Prepare solid models of the entire system with detail drawings of selected components.
5. User/client specifications
The required ballast capacity and the flight envelope will be provided.
Provision for a dump valve (not part of this design) needs to be made.
6. Outcomes
Structural requirements need to be derived by the designer with consideration of the relevant regulations
Material choice and a manufacturing technique need to be proposed
The seat mass needs to be predicted.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a landing skid for a UAV

Lecturer, Mr J Huyssen
Max students, 3

Project Description

1. Background
A UAV is to be flown and landed in the Kruger National Park. Its flight may need to be aborted at any time. There may then not be a suitable landing site available other than some clearings in the Bushveld. The autopilot will put the aircraft into descend mode towards a target for a controlled flight into terrain.
2. Problem statement
The ground impact of such a landing is problematic. To give the UAV a chance of remaining intact a retracted special landing skid is to be deployed before touch-down to attenuate the landing impact.
3. Objectives of the design
The dynamic response of the aircraft needs to be predicted and a suitable mechanism for this kinematic system has to be proposed offering best impact tolerance.
4. Drawings
Prepare solid models of the entire system with detail drawings of selected structural components.
5. User/client specifications
The all-up mass of the UAV is 18kg
The steepest approach slope is 4:1
Normal approach speed is 14m/s but no serious damage should occur up to 20m/s
Landings should be successful on any ground condition to be found in the park
In its retracted state the skid shall not add any drag to the aircraft
6. Outcomes
A dynamic model shall be provided and suitable spring damper properties shall be proposed
The structural joints shall be sized to withstand the worst case loads
The skid shape and friction properties shall be proposed
A skid deployment method shall be proposed

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a UAV launch dolly

Lecturer, Mr J Huyssen
Max students, 3

Project Description

1. Background
A UAV is to be launched from a short dirt strip in the Kruger National Park. To reduce all-up mass and maximize payload volume it has no wheels of its own for takeoff and therefore requires a launch dolly which remains on the ground.
2. Problem statement
The launch dolly can be electrically powered to get the UAV to flight speed over a short distance, adding to the electric power of the UAV. It will be radio controlled by the launch officer. It needs to be rugged for operation on poor ground conditions. It should carry the UAV such that it does not interfere with the aerodynamic response to aircraft controls.
3. Objectives of the design
The objective is to provide a steerable vehicle with suitable suspension properties, a proper power system and drive train arrangement. The UAV needs to rest on a suitable interface from which it can depart by rotating to the correct angle of attack when takeoff speed has been reached.
4. Drawings
Prepare solid models of the entire system with detail drawings of selected structural components and suspension elements.
5. User/client specifications
The all-up mass of the UAV is 18kg
The takeoff speed is 15m/s but a speed of 20m/s should be attainable
Takeoff speed shall be attained within 40m
Operation of the vehicle shall be easy on any typical runway surface
6. Outcomes
The design of the vehicle shall be provided with and the properties of the suspension elements shall be specified. The motor power and battery capacity shall be proposed and the steering servo shall be specified. Suitable standard wheel shall be prescribed.

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Prof L Dala

CFD Analysis of Split Ailerons

Lecturer, Prof L Dala
Max students, 5

Project Description

1. Background
Efficiency, economy and environmental friendliness are the main issues that have to be taken into account when developing new aircraft. The Flying Wing configuration is predicted to cope with all of these in regions that conventional aircraft cannot achieve (NASA, 2001). This is mainly due to the shape of the flying wing, an airfoil-shaped fuselage affecting the whole body to create lift. Loosely connected to the European New Aircraft Concept research project, this investigation will deal with split ailerons: a special feature that could be applied to a flying wing in order to improve its performance.

2. Problem statement
3. Objectives of the design
The main aim of this investigation is to gain a set of numerical data in order to analyse the effects caused by the split ailerons for a low speed arrangement. As all of the findings described in the literature review have been obtained using wind tunnel measurements, a numerical analysis could help to better understand both the profits and the problems attached to this type of control device.
In addition, another objective is to explore the split ailerons at cruise speed (M=0.85).

4. Drawings
5. User/client specifications
6. Outcomes

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a Joined-Wing Aircraft - Aerodynamics Considerations

Lecturer, Prof L Dala
Max students, 5

Project Description

1. Background
The joined wing design is such a novel concept that could fulfil some of the expectations for further fuel-efficient flight.
The benefit of a joined wing configuration lies in the ability to create very high aspect ratio wings due to the bracing effect of the second aerofoil. A high aspect ratio wing is slender and has a high span, becoming aerodynamically more efficient. In conventional airplane configurations, large wing spans are structurally demanding, bringing the penalty of heavy wings and increased profile drag, since large spans mean very thick wings at the root in order to counteract the large bending moments. This penalty can be avoided by the joined wing configuration. Since a joined wings system has a larger structural depth, larger wing spans can be realized.
High aspect ratio, large span wings reduce the vortex drag, also called induced drag, as compared to a low aspect ratio wing considerably and also increase the lift produced, thus increasing the L/D ratio of the aeroplane (Stinton, 1998).
Some preliminary work in the area of the joined wing aerodynamics promise 15-20% higher L/D, as compared to conventional concepts, and thus an increase in the efficiency of the aircraft (Nangia, 2008).

2. Problem statement
3. Objectives of the design
The objective of this work is primarily to first determine all the main wing parameters for a joined wing design that can compete with a mid-range aeroplane like the A321 and then further, to determine the essential parameters that have the greatest effect on the performance of a joined wing configuration, i.e. Cl/Cd, etc., at a set cruising speed and cruising altitude. This work is meant to lay the foundation for further detailed study in the aerodynamic performance and optimisation of a joined wing concept for the passenger transport industry.

4. Drawings
5. User/client specifications
6. Outcomes

Category

Aeronautical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mr BD Bock

Design of a Spirulina centrifuge

Lecturer, Mr BD Bock
Max students, 3

Project Description

1. Background
Worldwide there has been a large interest in the use of microalgae to provide various products, such as biofuels, pharmaceuticals and nutraceuticals. This is due to their ability to produce yields well above that of traditional agriculture, combined with the opportunity that biotechnology and the new field of synthetic biology have provided, by progressing to the point of being able to alter the very genetic make-up of organisms.

Spirulina, perhaps the oldest microalgae nutraceutical, is a well-known for its high nutrient content and is grown world-wide as a health supplement. It provides an ideal starting point for this burgeoning field.

Centrifuges are a common method of harvesting Spirulina. They achieve this through the use of centrifugal motion to separate the different density products.

2. Problem statement
A start-up Spirulina manufacturer requires a centrifuge to separate the Spirulina from its water-based growth medium. This centrifuge will act as the bulk separation process prior to final drying.

3. Objectives of the design
Design a low-cost centrifuge capable of separating Spirulina from the water

4. Drawings
Drawings as required by the course outcomes.

5. User/client specifications
To be provided.

6. Outcomes
Provide manufacturing drawings for the custom made parts and technical specifications of the catalogue parts.
Further specific requirements as per study guide.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a stationery stand-alone cyclonic dust separator

Lecturer, Mr BD Bock
Max students, 3

Project Description

1. Background
Cyclonic separators are used throughout industry to separate solid particles from air streams. They are low cost and often used as “first-pass” separators in particle filtering systems.

2. Problem statement
A pet food producer wishes to install a central vacuum system, making use of a cyclonic separator and bag filter. The system requires an integral blower/fan.

3. Objectives of the design
Design a central vacuum system consisting of a cyclonic separator and bag filter with integral fan.

4. Drawings
Drawings as required by the course outcomes.

5. User/client specifications
• Space constraints/Dimensional requirements to be supplied on request.
• 4 operators must be able to use it at once with a suction flow rate of 150 SCFM on their 2” lines.

6. Outcomes
• Provide manufacturing drawings for the custom made parts and technical specifications of the catalogue parts.
• Further specific requirements as per study guide.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a desalination test rig to test polymeric tubes

Lecturer, Mr BD Bock
Max students, 1

Project Description

1. Background
Thermal desalination makes use of thermal energy, usually in the form of hot water or steam, to drive the desalination typically of sea water. While still cost prohibitive compared to Reverse-Osmosis if the heat needs to be specifically produced for the desalination process, it can provide synergistic opportunities if a waste heat source can be utilised.

Horizontal Falling Film Evaporators are commonly used in such desalination applications. The sea water is sprayed over a horizontal tube bundle, with a hot medium flowing within the tubes thus boiling and evaporating the thin falling film that forms on the outside of the tubes.

Despite their excellent corrosion properties, polymers have traditionally not been used in these falling film evaporators due to their low thermal conductivity compared to copper alloys and the like. However, as highlighted by the recent development of graphite impregnated polypropylene tubes by the University of Bremen, with reported heat transfer properties that approach those of traditional evaporator materials, polymeric evaporators may provide a cost and fouling benefit if this hurdle can be overcome.

2. Problem statement
An experimental rig is required for future testing of metallic and non-metallic tubes

3. Objectives of the design
Design the salt water/brine/clean water circuit of a thermal desalination test rig. The main test section must comprise a horizontal tube bundle that can be fitted with metallic or non-metallic tubes and a distributor system to mimic those seen in commercial falling film evaporators.

4. Drawings
Drawings as required by the course outcomes.

5. User/client specifications
• The circuit must interface with the installed cold water, hot water and glycol systems in the Thermolab for heating and cooling requirements.
• Low cost is a key criteria.
• As much flexibility as is practical is required in terms of operation, modification and operating range.

6. Outcomes
• Provide manufacturing drawings for the custom made parts and technical specifications of the catalogue parts.
• Further specific requirements as per study guide.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a Municipal Thermal Desalinator

Lecturer, Mr BD Bock
Max students, 3

Project Description

1. Background
Thermal desalination makes use of thermal energy, usually in the form of hot water or steam, to drive the desalination of sea water.

While cost prohibitive compared to Reverse-Osmosis if the heat needs to be specifically produced for the desalination process, it can provide synergistic opportunities if a waste heat source can be utilised.

Considering the overall arid nature of South Africa and the ever increasing population, desalination may prove to be a vital part of future South African utilities.

2. Problem statement
A waste heat source at the coast is available and the municipality wants to make use of it to provide additional drinking water to their water restricted community. Design a single-stage thermal desalination plant to make use of this waste heat source.

3. Objectives of the design
Produce fresh water from a feed source of salt-water drawn in from the ocean.

4. Drawings
Drawings as required by the course outcomes.

5. User/client specifications
• The unit must have a single stage evaporation process and be compact in nature (plant footprint minimal)
• The head loss through the desalinator must be provided to determine whether a modification to the existing pumping station will be required.
• Other details to be provided.

6. Outcomes
• Provide manufacturing drawings for the custom made parts and technical specifications of the catalogue parts.
• Further specific requirements as per study guide.
• Should the device fall under the Pressure Equipment Regulations, basic theory and good engineering judgement will be employed to design the device, rather than adherence to design codes, as would be required in industry.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mr T Botha

Electronically-controlled CVT

Lecturer, Mr T Botha
Max students, 2

Project Description

Background
An essential part of the drivetrain of the TuksBaja vehicle is the CVT (Continuously Variable Transmission). As the name suggests it functions as a gearbox for the vehicle. There are two parts to the CVT namely the primary and the secondary. The characteristics for both of these parts are controlled mechanically by springs and flyweights for the primary, and springs and a helix for the secondary.

Problem statement
Design an implementable electronically-controlled actuator system that will control the characteristics of the CVT (both primary and secondary). The main design focus will be to determine a suitable mechanism and actuator for each part of the CVT.

Objectives of the design
Design the actuation mechanism and determine the type of actuators that would give the configuration the required characteristics. The design should make it possible to easily change the characteristics if necessary.

Drawings
The required parts to enable actuation of the primary and secondary CVT. The placing of these parts and electrical equipment on the vehicle.

User/client specifications
The characteristics of the CVT must be fully adjustable. The vehicle must be capable of all performance challenges at a Baja SAE event.

Outcomes
A electronically-controlled CVT of which the characteristics are fully adjustable.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Briggs Stratton Auxiliary Power Unit

Lecturer, Mr T Botha
Max students, 2

Project Description

Background
During field testing with the Land Rover test vehicle of UP, there is regular need for an air compressor, a hydraulic oil pump or an alternator to provide 12V DC power. This regularly causes undesirable delays in the testing.

Problem statement
Design an auxiliary power unit powered by a Briggs and Stratton engine.

Objectives of the design
The objective of this study is to develop an auxiliary power unit (APU) that utilises a Briggs Stratton engine. This unit must be able to supply compressed air, hydraulic oil flow and 12V DC power and must be able to easily switch between the different modes. It must also be possible to fit this unit to the test vehicle when necessary and contain some form of vibration and sound isolation.

Drawings
Drawings are required of the system used to switch between the modes, as well as of the coupling between the Briggs Stratton engine and the generators.

User/client specifications
Efficiently convert the power from a Briggs Stratton engine to supply enough compressed air, hydraulic flow and 12V DC as required by the systems on the Land Rover test vehicle.

Outcomes
A full design of an APU that can easily switch between supplying compressed air, hydraulic oil flow or 12V DC power.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Kinetic sculpture of a Baja vehicle

Lecturer, Mr T Botha
Max students, 2

Project Description

Background
Marketing is a very important part of any business and the best marketing is done visually. The Vehicle Dynamics Group of the University of Pretoria requires a sculpture to showcase the abilities of the Baja vehicle to passers-by.

Problem statement
Design a wall-mounted full-scale kinetic sculpture of Baja vehicle.

Objectives of the design
Design a kinetic sculpture of a Baja vehicle able to simulate the vehicle driving over obstacles. The simulation must include turning of the wheels, as well as suspension actuation, without making excessive noise.

Drawings
Drawing are required of the actuation system of the sculpture.

User/client specifications
The kinetic sculpture must be able to showcase the movement of the Baja vehicle without making excessive noise.

Outcomes
A kinetic sculpture of the Baja vehicle.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a tyre testing rig

Lecturer, Mr T Botha
Max students, 2

Project Description

Background
Tyres are an essential part of a vehicle and generate the forces required to steer, brake and accelerate. A better understanding of these force generation properties will greatly aid the design of vehicles and safety systems, but measuring these forces have proven to be tedious.

Problem statement
Design a tyre test rig capable of being towed behind a moving vehicle. The trailer should be able to measure all the forces generated by the fitted tyres and provide adjustments for side-slip angle, camber angle, as well as castor angle. The wheels should also be able to brake and be powered in order to generate a friction circle.

Objectives of the design
Design a tyre test rig capable of generating a friction circle from lateral and longitudinal force results to better the understanding of the force generation capabilities of a tyre. The design should not deform under loading.

Drawings
Detailed drawings of the brake system, as well as of the side-slip, camber and castor adjustment mechanism.

User/client specifications
The tyre test rig must deliver data from which a friction circle can be generated for different camber and castor angles.

Outcomes
A tyre test rig with braking and adjustable side-slip angle, camber angle and castor angle.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a four poster rig

Lecturer, Mr T Botha
Max students, 2

Project Description

Background
Although field testing of suspension systems can provide valuable insight to the response of a vehicle, it is coupled with many uncertainties which influence the test data. It can also be hard to accurately replicate the input to a system when performing validation. Laboratory tests allow for more control of testing parameters and can yield more accurate results if managed correctly.

Problem statement
Design a four poster test rig capable of vertically actuating the wheels of a vehicle to simulate it traveling on a predefined road.

Objectives of the design
Design a four poster rig capable of simulating the road input to the tyres and suspension system of a four wheeled vehicle.

Drawings
Detailed drawings of the actuation cylinders.

User/client specifications
The four poster rig must be able to simulate road input to the vehicle and must be compatible with off-road terrain profiles.

Outcomes
A four poster rig for use in laboratory testing.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mr M Kapp

Electronically-controlled CVT

Lecturer, Mr M Kapp
Max students, 2

Project Description

Background
An essential part of the drivetrain of the TuksBaja vehicle is the CVT (Continuously Variable Transmission). As the name suggests it functions as a gearbox for the vehicle. There are two parts to the CVT namely the primary and the secondary. The characteristics for both of these parts are controlled mechanically by springs and flyweights for the primary, and springs and a helix for the secondary.

Problem statement
Design an implementable electronically-controlled actuator system that will control the characteristics of the CVT (both primary and secondary). The main design focus will be to determine a suitable mechanism and actuator for each part of the CVT.

Objectives of the design
Design the actuation mechanism and determine the type of actuators that would give the configuration the required characteristics. The design should make it possible to easily change the characteristics if necessary.

Drawings
The required parts to enable actuation of the primary and secondary CVT. The placing of these parts and electrical equipment on the vehicle.

User/client specifications
The characteristics of the CVT must be fully adjustable. The vehicle must be capable of all performance challenges at a Baja SAE event.

Outcomes
A electronically-controlled CVT of which the characteristics are fully adjustable.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Briggs Stratton Auxiliary Power Unit

Lecturer, Mr M Kapp
Max students, 2

Project Description

Background
During field testing with the Land Rover test vehicle of UP, there is regular need for an air compressor, a hydraulic oil pump or an alternator to provide 12V DC power. This regularly causes undesirable delays in the testing.

Problem statement
Design an auxiliary power unit powered by a Briggs and Stratton engine.

Objectives of the design
The objective of this study is to develop an auxiliary power unit (APU) that utilises a Briggs Stratton engine. This unit must be able to supply compressed air, hydraulic oil flow and 12V DC power and must be able to easily switch between the different modes. It must also be possible to fit this unit to the test vehicle when necessary and contain some form of vibration and sound isolation.

Drawings
Drawings are required of the system used to switch between the modes, as well as of the coupling between the Briggs Stratton engine and the generators.

User/client specifications
Efficiently convert the power from a Briggs Stratton engine to supply enough compressed air, hydraulic flow and 12V DC as required by the systems on the Land Rover test vehicle.

Outcomes
A full design of an APU that can easily switch between supplying compressed air, hydraulic oil flow or 12V DC power.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Kinetic sculpture of a Baja vehicle

Lecturer, Mr M Kapp
Max students, 3

Project Description

Background
Marketing is a very important part of any business and the best marketing is done visually. The Vehicle Dynamics Group of the University of Pretoria requires a sculpture to showcase the abilities of the Baja vehicle to passers-by.

Problem statement
Design a wall-mounted full-scale kinetic sculpture of Baja vehicle.

Objectives of the design
Design a kinetic sculpture of a Baja vehicle able to simulate the vehicle driving over obstacles. The simulation must include turning of the wheels, as well as suspension actuation, without making excessive noise.

Drawings
Drawing are required of the actuation system of the sculpture.

User/client specifications
The kinetic sculpture must be able to showcase the movement of the Baja vehicle without making excessive noise.

Outcomes
A kinetic sculpture of the Baja vehicle.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a tyre testing rig

Lecturer, Mr M Kapp
Max students, 2

Project Description

Background
Tyres are an essential part of a vehicle and generate the forces required to steer, brake and accelerate. A better understanding of these force generation properties will greatly aid the design of vehicles and safety systems, but measuring these forces have proven to be tedious.

Problem statement
Design a tyre test rig capable of being towed behind a moving vehicle. The trailer should be able to measure all the forces generated by the fitted tyres and provide adjustments for side-slip angle, camber angle, as well as castor angle. The wheels should also be able to brake and be powered in order to generate a friction circle.

Objectives of the design
Design a tyre test rig capable of generating a friction circle from lateral and longitudinal force results to better the understanding of the force generation capabilities of a tyre. The design should not deform under loading.

Drawings
Detailed drawings of the brake system, as well as of the side-slip, camber and castor adjustment mechanism.

User/client specifications
The tyre test rig must deliver data from which a friction circle can be generated for different camber and castor angles.

Outcomes
A tyre test rig with braking and adjustable side-slip angle, camber angle and castor angle.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design of a four poster rig

Lecturer, Mr M Kapp
Max students, 2

Project Description

Background
Although field testing of suspension systems can provide valuable insight to the response of a vehicle, it is coupled with many uncertainties which influence the test data. It can also be hard to accurately replicate the input to a system when performing validation. Laboratory tests allow for more control of testing parameters and can yield more accurate results if managed correctly.

Problem statement
Design a four poster test rig capable of vertically actuating the wheels of a vehicle to simulate it traveling on a predefined road.

Objectives of the design
Design a four poster rig capable of simulating the road input to the tyres and suspension system of a four wheeled vehicle.

Drawings
Detailed drawings of the actuation cylinders.

User/client specifications
The four poster rig must be able to simulate road input to the vehicle and must be compatible with off-road terrain profiles.

Outcomes
A four poster rig for use in laboratory testing.

Category

Mechanical

Group

Vehicle Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mr M Mehrabi

Design a shell and tube heat exchanger

Lecturer, Mr M Mehrabi
Max students, 3

Project Description

1. Background
Heat exchanger is a device used for effective heat transfer between two fluids (gas or liquid) from one to another. Heat exchangers are used in various industries including HVAC, plants, power and process industries and many others.

2. Problem statement
Design a shell and tube heat exchanger for distilled water-raw water with two tube side passages and one shell side passage.

3. Objectives of the design
The objective of this design project is to design a shell and tube heat exchanger.

4. Drawings
Detailed CAD drawing of designed heat exchanger is required which should be containing of all required sizes and geometry of all components.

5. User/client specifications

Different input, output temperatures, flow rate and heat load will define based on the number of student apply for this project.

6. Outcomes
Refer to study guide for ESCA

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a solar desalination system based on humidification-dehumidification process

Lecturer, Mr M Mehrabi
Max students, 3

Project Description

1. Background
As result of the growing human demands for fresh (potable) water, several desalination methods have been suggested during the past three decades. Examples of great interest can be easily found in many industrial applications. HD (humidification–dehumidification) method is one of those methods.

2. Problem statement
Design the HD (humidification–dehumidification) unit with a closed air cycle and water heating system.

3. Objectives of the design
The objective of this design project is to design a desalination system based on HD (humidification–dehumidification) process which uses a solar collector to produce hot water.

4. Drawings
Detailed CAD drawing of HD (humidification–dehumidification) unit is required which should be containing of all required sizes and geometry of all components.

5. User/client specifications
Different air mass flow rate, Saline water flow rate, cooling water flow rate, total volume, humidifier's height and dehumidifier's height will define based on the number of student apply for this project.

6. Outcomes
Refer to study guide for ESCA

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Design a condenser for typical steam power plant

Lecturer, Mr M Mehrabi
Max students, 4

Project Description

1. Background
Condenser is a device which is being used to condense a substance from gas phase to liquid phase by cooling it. To do so, the latent heat is given up by the substance, and will transfer to the condenser coolant. Condensers are typically heat exchangers which have various designs and in many sizes ranging from small to very large industrial-scale units used in power plants.
2. Problem statement
The student needs to investigate and find the operating condition of a typical steam power plant and after the approval of the study leader he/she will start the design. Therefore, the data which needs include inlet and outlet conditions as well as the mass flow the condenser.

3. Objectives of the design
The objective of this design project is to design a condenser and find the optimum size of the condenser for typical steam power plant.

4. Drawings
Detailed CAD drawing of the condenser is required which should be containing of all required sizes and geometry of all components.

5. User/client specifications
More detailed information about the specifications of the project will be given by the lecturer.

6. Outcomes
Refer to study guide for ESCA

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Mr W LeRoux

The design of a small-scale dish-mounted hybrid solar thermal Brayton cycle

Lecturer, Mr W LeRoux
Max students, 4

Project Description

1. Background
Air can be heated with concentrated solar power in a solar receiver. A Brayton cycle can be coupled with the solar collector so that a micro-turbine can be operated to produce electrical power for a household/small community. Heat can be provided or added with the use of a fuel burner whenever the sun is not available, making the system a hybrid system.

2. Problem statement
A small-scale solar hybrid Brayton power cycle should be operated from solar power and fuel so that a household/small-community can be provided with electrical power.

3. Objectives of the design project
A solar collector, recuperator and fuel burner should be designed. Other components should be selected. Flownex can be used as design tool.

4. Drawings
There is sufficient scope to meet the departmental requirements for the drawings. Design drawings of the solar receiver, recuperator and fuel burner should be presented.

5. User / client specification
The solar collection area will be given as design requirement so that the system can produce between 2 – 20 kW of electrical power. The designer must compile the specifications in detail.

6. Outcomes of the design
A workable hybrid solar thermal Brayton system design and cost analysis is required for manufacturing.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

The design of a small-scale solar thermal Rankine cycle

Lecturer, Mr W LeRoux
Max students, 3

Project Description

1. Background
Water can be heated with concentrated solar power to produce steam in a solar receiver. The solar receiver can be coupled to a Rankine power cycle wherein a micro-turbine is driven to produce electrical power for a household/small community.

2. Problem statement
A small-scale Rankine power cycle should be designed to operate from solar power so that a household/small-community can be provided with electrical power.

3. Objectives of the design project
Heat exchangers and a solar collector should be designed for the cycle. The other components required in the system should also be selected. Flownex can be used as design tool.

4. Drawings
There is sufficient scope to meet the departmental requirements for the drawings. Drawings of the solar receiver and heat exchangers are required.

5. User / client specification
The solar collection area will be given as a design requirement so that the net power output of the cycle falls within 2 - 20kW. The designer must compile the specifications in detail.

6. Outcomes of the design
A solar thermal Rankine system design, ready for manufacturing, is required. A cost analysis should also be done.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

The design of an integrated multi-step solar receiver and recuperator for a small-scale dish-mounted

Lecturer, Mr W LeRoux
Max students, 3

Project Description

1. Background
With the use of concentrated solar power, air can be heated in a solar receiver mounted on a solar dish. A Brayton cycle can be coupled with the solar collector so that a micro-turbine can be driven to produce electrical power output for a household/small community.

2. Problem statement
To prevent heat losses and tube connections, the recuperator of a solar thermal Brayton cycle can be integrated into the solar receiver to form a single unit. An integrated multi-step solar receiver is required wherein air can be pre-heated with exhaust air from the micro-turbine and also heated with solar power. This should all be done within one component, coupled to the micro-turbine, at the focus point of the dish. Receiver and recuperator flow channels should divide the flow of air so that effective heat transfer can take place.

3. Objectives of the design project
A solar receiver with integrated recuperator, as well as the solar collector, should be designed. Flownex can also be used as design tool.

4. Drawings
Detail manufacturing drawings of the integrated solar receiver and recuperator unit should be made.

5. User / client specification
The designer must compile the specifications in detail.

6. Outcomes of the design
A workable design of the integrated solar receiver and recuperator unit must be provided for manufacturing and a cost analysis is required.

Category

Mechanical

Group

Thermofluids Research Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Dr NDL Burger

CMTI Project

Lecturer, Dr NDL Burger
Max students, 2

Project Description

CMTI Project

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

N/A

Vacuum system for ultra-low profile mining

Lecturer, Dr NDL Burger
Max students, 1

Project Description

CMTI Consulting had developed a battery operated multitrack machine, the MT100, which is now going to be used for the sweeping of old workings in various mines. The machine is as shown in the attached Figure. The machine do have a payload of 250 kg.

The areas that are going too swept is fairly flat and open. The typical size is 100 m wide x 800 m long and as low as 500 mm however it is important that the vacuum system must be housed on board the machine as a trailing pipe system is not going to work. There is a large number of obstacles like wood etc. lying around the panels making a trailing system impractical.
It is expected of the student to design the vacuum system that can draw of the dust that is going to be generated in front of the rotary brush. As this dust is going to contain gold fines it is essential that the dust be collected and stored
The machine is powered by a 60 Ah LiFeYPo4 battery pack operating at 72 V. From this battery pack the 8 motors and sweeper brush motor must also be powered so it essential that the vacuum system draw as little current as possible. The battery system is being design as a hot swappable system to allow for a 24/7 operation. The vacuum system can therefore be driven with either a DC motor or a DC-AC converter can be fitted to accommodate AC motor.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

CMTI

Ultra-low profile sweeper drive system

Lecturer, Dr NDL Burger
Max students, 1

Project Description

he system that is under development by CMTI for sweeping the old working in the gold mines is as shown in the above picture. The system consists out of a rotary bush connected to a vacuum system. The rotary brush’s angle of attack can be adjusted to accommodate the direction of travel in the panels.
The overall height of the system must be restricted to less than 500 mm as this is the height in some of the panel that is to be swept.
It is expected of the student to design the drive system for the rotary brush. The prime driver will be a permanent magnet synchronous motor (PMSM) powered through the power electronics from the 60Ah battery pack. The advantage of these motors is that is gives full torque from1 rpm but it is more efficient (about 98%) in the maximum speed range. A drive system in the hub of the rotary brush will have to be designed incorporating the PMSM and suitable gearbox. If need be a gearbox can be designed to suit as CMTI do have the facility to manufacture our own gearboxes.

Category

Mechanical

Group

Dynamic Systems Group

External Leader

N/A

External Leader Location

N/A

External Organisation

CMTI