PROCEDURE RELATED TO POSTGRADUATE STUDIES

Post-graduate studies and research

Jan 2019

INTRODUCTION

Welcome to post-graduate studies and research at the department of Mechanical Engineering, Mechatronics and Industrial Design. Stemming from our mission to be locally relevant and internationally competitive, the Department of Mechanical Engineering, Mechatronics and Industrial Design at Tshwane University of Technology (TUT) places high emphasis on quality research, and considers the creation, application and transfer of knowledge as one of its major functions. The Department responds to the needs of the country by proactively contributing to the shaping of the future.

Included is information on the structuring of the qualifications, the pre-requisites, bursaries that are available, the procedure to initiate your Masters or Doctoral studies, approximate cost of studies, the possible fields of study, general information on supervision and relevant contact details.

STRUCTURE OF THE QUALIFICATIONS

The offered qualifications are as follows:

- Masters of Engineering in Mechanical Engineering (MEng): Qualification code: MEME17
  - The minimum duration of studies is 1 year
  - The maximum duration for full-time studies is 2 years
  - The maximum duration for part-time studies is 3 years

- Doctor in Engineering: (DEng): Qualification code: DENG17
  - The minimum duration for full-time studies is 2 years
  - The maximum duration for full-time studies is 4 years
  - The maximum duration for part-time studies is 5 years

PRE-REQUISITES

- All BTech candidates who have not completed Engineering Research Methodology, System Modelling and Statistical Data Analysis (or their equivalents) at NQF Level 7 or 8, will be required to complete these subjects concurrently with the MEng programme. Students holding a BEng or BSc Engineering degree are only required to register and pass the Research Methodology course.
- A Bachelor’s Degree in Technology: Engineering: Mechanical (B Tech) or any equivalent qualification for MEng studies. An M Tech or equivalent is required for entrance into doctoral studies (DEng). Proof of the qualification should be submitted with the application.
- Since Mechatronics is an integration of mechanical, electrical, electronic, information technology and computer studies, any student with a Bachelor’s degree in these fields that wishes to do an MEng may be considered. Each application will be considered on an individual basis. Additional subject(s) maybe prescribed and these need to be completed before the student will be allowed to continue with the MEng.
PROCEDURE

Step 1: Application and registration

a) Forward the following documents to the departmental research officer via e-mail: Ratlhogonm@tut.ac.za

- Certified copy of previous academic qualifications;
- Curriculum Vitae (CV);
- Full previous academic records;
- 1 page document on the possible research/project you would like to conduct (in order to nominate supervisor/s for you) – Refer to the research areas/topic links below.
- SAQA (South African Qualifications Authority) Certificate of Evaluation (only for foreign students) website: www.saqa.org.za
- Certified copy of ID or passport/visa; and
- Application form signed by student and supervisor

b) The departmental research officer will distribute the application documents to relevant staff or supervisors for consideration

c) The provisional supervisor(s), who intend to accept the applicant as his or her postgraduate student based on the capacity and potential of the applicant, will give feedback to the research officer or student

d) If necessary, the supervisor(s) may contact the applicant to have an interview/meeting

e) If the supervisor is satisfied with the applicant, and the applicant meets the minimum requirements, the application form will be signed by the supervisor and HoD or the Chairperson of DRC (Departmental Research Committee)

f) The research officer will submit the signed application to the admission office (Postgraduate office)

g) The applicant will then receive the acceptance letter from the Postgraduate Office

h) Accepted applicants will then register where the supervisor and HoD or Chairperson of DRC or Section Head should sign the registration form

i) After registration, the postgraduate student will commence the research under the supervision of the supervisor(s). **Ensure that you always work through your MAIN supervisor regarding all research activities.**

Step 2: Approval of provisional title and study panel

a) Discuss and finalize your topic and proposal with your study leader / supervisor

b) Complete the application form (PGS 00 form: “APPLICATION FOR PROVISIONAL TITLE, PROVISIONAL STUDY PANEL AND CLEARANCE TO REGISTER”), as well as a provisional 1 page summarised description of your intended project. The application form is available from your supervisor. **Note that if you have an external study leader in mind, a CV and motivation letter of the study leader must be handed in with the application**

c) Submit the completed PGS 00 form to the above department research officer to be approved by DRC

d) The DRC approved PGS 00 form will then be submitted to FCPS (Faculty Committee for Postgraduate Studies) for notification
Step 3: Proposal writing and approval

a) Start the literature review
b) Compile the full proposal and complete PGS 01 form and submit all required documents to the departmental research officer

The student needs to present his or her signed proposal to DRC * See presentation date schedule below (note: booking is compulsory: 1st come 1st serve basis, max 4 students per date/session). Note that your supervisor/co-supervisor must attend your presentation.

<table>
<thead>
<tr>
<th>Presentation/ Colloquium Venue: Building 3-309</th>
<th>Closing date for Agenda presentations/colloquium 12:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00 – 13:00</td>
<td></td>
</tr>
<tr>
<td>7 February</td>
<td>4 February</td>
</tr>
<tr>
<td>7 March</td>
<td>4 March</td>
</tr>
<tr>
<td>11 April</td>
<td>8 April</td>
</tr>
<tr>
<td>16 May</td>
<td>13 May</td>
</tr>
<tr>
<td>11 July</td>
<td>8 July</td>
</tr>
</tbody>
</table>

Students must book in advance with the Research Administrator for a date, after the date is secured the student must send relevant documents to Miss Ratlhogo by Monday before the presentation date. If documents aren’t sent in time it will be an automatic cancellation

c) DRC will then consider PGS 01 form and its accompanying PGS01 “DRC Evaluation” form for approval. If the proposal is approved, the research officer will submit these forms to FCPS for final approval
d) The proposal should be completed within six months of registration

Step 4: Implement and complete your research project to the satisfaction of your supervisors

Step 5: After the completion of the project, with recommendation from your supervisor, a *colloquium is arranged where you must present your research.
*Note that your supervisor/co- supervisor must attend your colloquium. Depending on the outcome of the colloquium, the supervisor will advise the student of any changes that need to be made

* See date schedule above (note: booking is compulsory: 1st come 1st serve basis, max 4 students per date/session)

Step 6: Appointment of external assessors, where PGS 02 form will be completed by the supervisor and to be recommended and approved by various committees within TUT (DRC, FCPS and SCPS)

Step 7: Present your research to a defence panel (for Doctoral students only)
APPROXIMATE COSTS

The approximate costs are as follows:

- MEng . . . . . . . R 20 000
- DEng . . . . . . . R 23 000

- Re-registration fee (returning students continuing their studies, amount per year for every consecutive year of study after the first year) . . . R 700

- A minimum of R 1500 is payable upon registration

- The registration fees for MEng and DEng studies are payable within the first year of study.

- Note that these fees are approximate costs. The amounts are subjected to change, and are included here only as an indication. You can enquire the latest fees at Student services or the Post-graduate office (012) 382 5257

IMPORTANT

- Closing date for applications for first semester and block 0 (January – December): 31 January.
- Closing date for registration for first semester and block 0 (January – December): 31 March.
- Closing date for applications for second semester and block 4 (July – June): 31 July.
- Closing date for registration for second semester and block 4 (July – June): 30 September.
- **No late applications or registrations will be considered.**

STUDY GUIDANCE / SUPERVISION

- Typically, the main study leader/supervisor should have a Doctorate degree

- The supervisor needs to provide significant guidance to the student at Masters level, while more independent work is expected from the student at Doctoral level

- The student needs to meet regularly with his/her study leader/supervisor, who should be a subject matter expert in the field of study. It is the student’s responsibility to arrange these meetings. An external study leader may be appointed under special circumstances to guide the student, while the internal study leader will be responsible to ensure that the required academic standards are maintained

- The student needs to submit a monthly progress report to his supervisor/s. The submission date is the last Friday of each month

- If relevant, ensure that ethical clearance is obtained before you commence your studies-contact your supervisor

- Note that all work is subjected to plagiarism checks. More information can be obtained from: [www.plagiarism.org](http://www.plagiarism.org)

- Further details will be provided by the supervisor
FIELDS OF STUDY

The following areas are currently available within the Department of Mechanical Engineering, Mechatronics and Industrial Design. The associated group leader together with his research profile website link is also shown. Please contact the group leader/supervisor to determine availability and details of projects, as well as capacity to accommodate you.

- **Material Science**: Composites & High Strength Alloys (Dr Jamiru & Dr Beneke)
  
  Link: [Dr Jamiru](#)

- **Structural Dynamics**: Mechanical Sound and Vibration (Dr Desai)
  
  Link: [Dr Desai](#)

- **Energy**: Refrigeration and Heat Pump Systems (Prof Huan)
  
  Link: [Prof Huan](#)

Part-time students / research projects from companies / industry

Should a student wish to select his/her own topic, and none of the department’s staff is a subject matter expert in that particular topic, an external study leader, who is an expert in that field of study, should be appointed as supervisor. An appropriately qualified lecturer will then be appointed as a co-supervisor.

GENERAL ENQUIRIES

Kindly address all general enquiries to:

Miss Nthabiseng Ratlhogo (012) 382 5874 (Department Research Administrator)
Email: [Ratlhogonm@tut.ac.za](mailto:Ratlhogonm@tut.ac.za)
### Summary of procedures related to postgraduate studies

<table>
<thead>
<tr>
<th>Process</th>
<th>STEP 1</th>
<th>STEP 2</th>
<th>STEP 3</th>
<th>STEP 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td>Evaluation / Selection</td>
<td>Final study panel</td>
<td>Conduct research</td>
<td>Assessment</td>
</tr>
<tr>
<td>Granting of equivalence/status</td>
<td>Ethical clearance</td>
<td>Colloquium</td>
<td>Summary report of assessment</td>
<td></td>
</tr>
<tr>
<td>Provisional title</td>
<td>Drafting and signing of MoU</td>
<td>Final title</td>
<td>Defence (Doctoral)</td>
<td></td>
</tr>
<tr>
<td>Provisional study panel</td>
<td>Registration</td>
<td>Language editing</td>
<td>Final results</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Appointment of assessors</td>
<td>Final hard copies and CD of report</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Documentation</th>
<th>PGS 00</th>
<th>PGS 01</th>
<th>PGS 02</th>
<th>PGS 04/05</th>
</tr>
</thead>
<tbody>
<tr>
<td>PGS 01 DRC Eval.</td>
<td></td>
<td></td>
<td></td>
<td>Requisition for printing form</td>
</tr>
<tr>
<td>Check List form for hardbound copies</td>
<td></td>
<td></td>
<td>Addendums: PGS 04/05</td>
<td></td>
</tr>
</tbody>
</table>

| Amendments PGS 03 | ↑ | ↑ | |
| Upgrade PGS 06 | ↑ | ↑ | ↑ |

| Timelines | Not exceeding two weeks (excluding students who applies for equivalence/status) | Up to 6 months | Up to 30 months for Masters degrees (Full-time and 42 Part-time) Up to 54 months for Doctoral degrees (Full-time and 78 months Part-time) |

| Reporting (supervisor) | ↑ | ↑ | ↑ | ↑ |

| Reporting (PGS) | Date of approval of PGS 00 | *Date of approval of PGS 01 | Date of approval of PGS 04/05 |
1. DIVISION OF MECHANICS AND MATERIALS

Engineers make things. They make them out of materials using the principles of mechanics. To make something out of a material you also need a process and not just any process. Process chosen must be compatible with the material selected for use.

The division of mechanics and materials is an area that is both vast in scope and extreme in depth, and this sustains an extremely fertile arena for university research, education, economic and entrepreneurial impact that spans the sciences, engineering, and is rapidly moving into medicine and agriculture. Principles of mechanics and materials research have generated countless advances in areas such as electronics, automotive/aerospace transportation, nanotechnology, biomechanics and materials.

2. KEY OBJECTIVES

- Strengthen research and development capabilities
- Consolidations of resources of the relevant programs in the unit
- Training for deserving staff members and students (undergraduate and Postgraduates)
- Provide consultancy services for the wider public, relevant industries and other institutions
- Enhance the profile of the Department

3. CORE LABORATORIES

- Materials Characterization Lab
- Mechanical Testing Lab
- Materials Processing Lab

4. CORE RESEARCH AREAS

Potential areas for research and development cover the under mentioned sectors (not limited)

- High performance composites & High strength alloys
- New emerging engineering materials
- Green Technology

4.1 High performance composites & high strength alloys - Dual-phase steels: are particulate composite belonging to a new class of high-strength low alloy (HSLA) steels. This class is characterized by a tensile strength value of approximately 550 MPa (80 ksi) and by a microstructure consisting of about 20% hard martensite particles dispersed in a soft ductile ferrite matrix. The term dual phase refers to the predominance in the microstructure of two phases, ferrite and martensite. However, small amounts of other phases, such as bainite, pearlite, or retained austenite, may also be present. In addition to high tensile strength, other unique properties of these steels include continuous yielding behavior, a low 0.2% offset yield strength, and a higher total elongation than other HSLA steels of similar strength. These properties make these steels applicable to wide range of engineering applications.
The effect of varying heat treatment temperature, time, alloy content and cooling rate on alloyed steel will be investigated to accurately determine effect of austenite dispersion on hardenability. Models predicting austenite dispersion in relation to hardenability of the steels will be tested in line with the key variables under given test conditions.

4.2 New emerging engineering materials - Glassy metals: A metal alloy masquerading as a glass is the first material to be fabricated that is strong and as tough as the strongest steel. It is expected that these materials could eventually replace steel in buildings, cars and bridge.

The term strength and toughness may be used interchangeably in everyday life, but until now, no materials have been found that display both these characteristics. Some materials such as glass, are strong—that is they are scratch resistance and it is difficult to permanently bend them out of shape when you place heavy load on them—but they also tend to be brittle. Others such as metal, are though—that is, they are more difficult to shatter—but they are generally more malleable.

The challenge has always been to achieve both high strength and toughness. The team will develop alloy that combines the best features of both using amorphous metals for specific applications using different mix of metal alloys to constitute the glassy material. Relevant mechanical tests will be conducted on the alloy to ascertain toughness and strength.

4.3 Green Technology - The field of "green technology" encompasses a continuously evolving group of methods and materials, from techniques for generating energy to non-toxic cleaning products. The present expectation is that this field will bring innovation and changes in daily life of similar magnitude to the "information technology" explosion over the last two decades. In these early stages, it is impossible to predict what “green technology” may eventually encompass.

Focus areas for intervention

- Conversion of waste (eg. Plastic) — to supplement coke in pig iron production and as binding agent
- Conversion of alien plants/vegetation — produce medicated soap, green fuel, etc
- The development of alternative fuels, new means of generating energy and energy efficiency systems play a critical role in the application of the technology

5. CONTACT
Dr. Tamba Jamiru
Department of mechanical Engineering
Building 3 Room 3-20
Tel: +27(0) 12 382 5840
E-mail: jamirut@tut.ac.za
1. **Introduction**

Stemming from our mission to be locally relevant and internationally competitive, the Department of Mechanical Engineering, Mechatronics and Industrial Design at Tshwane University of Technology (TUT) places high emphasis on quality research, and considers the creation, application and transfer of knowledge as one of its major functions. The Department responds to the needs of the country by proactively contributing to the shaping of the future.

In today’s competitive, high-tech society, noise and vibration are constantly present. Noise causes serious problems both at home and in the workplace, and the task of reducing noise and vibration is a subject currently focused on by authorities in many countries. Hence, the ever-growing demand for reducing community noise by designing better quality, low-noise emission products that can withstand severe dynamic conditions have increased drastically and will continue to do so as legislation on noise emission standards become higher. Similarly, manufacturers of mechanical products with vibrations causing acoustic noise, increasingly find themselves forced to compete on the noise levels of their products. Such competition has so far occurred predominantly in the automotive industry and in the rail and aeronautical industries to a lesser extent. However in Europe, domestic appliances and power tools are now being increasingly marketed stressing low noise levels. Hence, the prediction of noise and vibration characteristics of a product at its early stage of development is highly desirable.

In response to this, TUT has been active in research on dynamical systems since 2003. These activities eventually culminated in the establishment of the Structural Dynamics Group (SDG) in 2012. The SDG focuses primarily on structural sound and vibration (vibro-acoustics) and structural dynamics. These activities have gradually expanded to include a specialist Sound and Vibration laboratory at the Pretoria campus, with the aim of expanding these activities even further to the broader field of structural sound and vibration including biomechanics in collaboration with UNISA.

The SDG strives to provide quality-driven postgraduate training, industry-relevant research and development work to master’s and doctoral students on the basis of postgraduate projects. These projects are completed in partial or complete fulfilment of the requirements for the particular master’s or doctoral degree programmes. The aim is to produce highly competent, value-adding research graduates capable of supporting industry and the community in relevant problems and projects. The group actively collaborates with industry, the CSIR, University of Pretoria (UP), Eskom, UNISA and
many others with its projects and programs supported through both internal and external funding.

2. **Research focus areas**

*Structural dynamics* is a field which describes phenomena such as resonance in structures and how connecting structures together affect the resonances, etc.

*Acoustics* is a discipline close to noise and vibration analysis as the causes of acoustic noise is often vibrations.

*Biomechanics* understanding and modelling (FEA) the material behaviour of tissues in order to solve health challenges and various diseases.

Within this sphere, the SDG currently entails a range of activities which include:

**Theme 1: Noise, vibration and harshness reduction of transportation systems**

Sound & vibration prediction and control, reduced-scale and similitude modeling, design & development, mathematical & numerical modeling (finite element analysis - FEA), experimental validation, correlation, evaluation, design sensitivity analysis and optimization of systems, technologies and products to reduce noise and vibration emissions of transportation systems. Typical examples are the reduction of interior noise levels in the passenger cabin and door panel vibration; analysis of road-tyre interaction of rolling tyres and its subsequent spindle forces; mathematical modeling of a reliable, automated, CAD-based volume generation algorithm of enclosed complex, three-dimensional cavities or domains; sensitivity analysis of different automotive door mount architectures on vibration and interior noise levels and the analysis and influence of absorbent poro-elastic components, such as interior trim, on the interior sound field.

**Theme 2: Dynamic characterization of materials including composites**

Modal analysis & numerical modeling, experimental validation, correlation and evaluation of natural frequencies. Experimental characterization of damping. Examples include the analysis of polymer and composite materials in terms of their dynamic behaviour (natural frequencies and damping characteristics) and applications.

**Theme 3: Sound radiation analysis and characterization of dynamical systems**

Sound & vibration prediction and control, reduced-scale modeling, design & development, mathematical & numerical coupled acoustic-structural modeling (finite element analysis), modal analysis, experimental validation, correlation, evaluation, design sensitivity analysis and optimization of the vibro-acoustic behaviour of small products and components such as automotive engine covers and automotive door hinge design/architectural studies.

**Theme 4: Asset integrity management**

Vibration analysis and development of predictive (FEA) models applied to power stations, transmission and distribution utilities such as transformers, voltage switch gear, power
line structures (pylons), capacitor banks, grinding mills, boiler tubing and pipes, steam turbines/blades, generator stators, mill gearboxes. Specific FEA modeling topics relate to boilers, natural frequencies of rotors on turbo-generators, fatigue & creep of turbine discs and residual stresses in turbine blades and rotor attachments.

**Theme 5: Biomechanics** (in collaboration with UNISA: Dr F Masithulela)

Our research investigations include theoretical and experimental work that are aimed at understanding various mechanisms of medical conditions. Research projects are designed to achieve scientific insights to better prevent human diseases and better understand the healing processes and the mechanisms of medical conditions. The nature of this research requires a multidisciplinary approach involving medical specialists, biologists, material engineers and scientists etc. Biomechanics is the study of biological systems through mechanical principles. Biomechanics is closely related to engineering, because it often uses traditional engineering sciences to analyze biological systems.

**Research Areas:**

- Experimental characterisation of soft biological tissues and biomaterials
- Hard tissue mechanics
- Mechanobiology of eye diseases
- Soft tissue mechanics and mechanobiology
- Cellular and viral mechanobiology in physiology and disease
- Mechanobiology of cardiovascular diseases and therapies
- Soft tissue regeneration

**Experimental Biomechanics**

**Computational Biomechanics**

**Soft Tissue Mechanics**

**Mechanobiology**

We empower people
### 3. Facilities

Some (not all) of the research facilities/equipment currently available at TUT are shown below:

<table>
<thead>
<tr>
<th>Item</th>
<th>Brief specification</th>
<th>Visual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic FFT signal/spectrum analysers</td>
<td>Various models available</td>
<td></td>
</tr>
<tr>
<td>Electro-dynamic shakers</td>
<td>High precision modal exciter - 100N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sentek Dynamics – 1000N</td>
<td></td>
</tr>
<tr>
<td>Impact (modal) hammers</td>
<td>Brue &amp; Kjaer 8206 22.7mV/N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brue &amp; Kjaer Type: 8202 21.04 mV/N</td>
<td></td>
</tr>
<tr>
<td>SVantek Portable sound and vibration analyser</td>
<td>912 AE</td>
<td></td>
</tr>
<tr>
<td>Current mode power amplifiers</td>
<td>Various models available</td>
<td></td>
</tr>
<tr>
<td>Acoustic sound calibrator</td>
<td>MVI Technologies Cal 21 01dB Stell</td>
<td></td>
</tr>
</tbody>
</table>

---

**We empower people**

Tel. (012) 382 5177, Fax (012) 382 5602, www.tut.ac.za  •  Privaatsak/Private Bag X680 PRETORIA
<table>
<thead>
<tr>
<th>Product Description</th>
<th>Specification/Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miniature ½” &amp; ¼” condenser microphones pressure field</td>
<td>BSWA MPA 401, 418, 416 50mV/Pa, 436 12.5mV/Pa with pre-amp circuitry, MP 206 30mV/Pa with pre-amp circuitry</td>
</tr>
<tr>
<td>Force transducers</td>
<td>Various models available</td>
</tr>
<tr>
<td>Accelerometers: sub-miniature tri-axial, teardrop, various sizes</td>
<td>Various models available</td>
</tr>
<tr>
<td>Sweep/Function Generator</td>
<td>FG-7005C</td>
</tr>
<tr>
<td>Rigid shaker tables</td>
<td>Various models available</td>
</tr>
<tr>
<td>Infrared thermography cameras</td>
<td>Various models available</td>
</tr>
<tr>
<td>DS - ABAQUS FEA simulation software</td>
<td>Full research edition V6.14</td>
</tr>
<tr>
<td>DS software: FeSafe, Isight, Tosca</td>
<td>Full research edition</td>
</tr>
<tr>
<td>MODENT modal analysis software</td>
<td></td>
</tr>
<tr>
<td>BSWA signal &amp; data acquisition software</td>
<td>VA-Lab4 Base 4 channels</td>
</tr>
</tbody>
</table>
4. Some of the facilities available at the University of Pretoria’s Sasol Laboratory for TUT students on collaborative projects

- Laser vibrometry for development of turbo machine blade damage detection algorithms
- Scanning laser vibrometry for damage detection studies on composite structures
- Durability investigations on composite panels
- Dynamic testing of an automotive vehicle model

(Pictures: Courtesy of the Department of Mechanical and Aeronautical Engineering, University of Pretoria)
Link to University of Pretoria’s Sasol Lab: Sasol Laboratory for Structural Mechanics

We empower people
5. Some of the facilities available at the University of South Africa on collaborative projects

This Lab is based at UNISA, School of Engineering, Department of Mechanical and Industrial Engineering. The Lab is equipped with sophisticated equipment including newly developed biaxial machine and cellculture.

<table>
<thead>
<tr>
<th>PRODUCT DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Biomaterial biaxial testing machine (BT 50 mm)</td>
</tr>
<tr>
<td>2 A micro-scale tension/compression test system</td>
</tr>
<tr>
<td>3 Mechano-Culture B1 (MCB1-200)</td>
</tr>
<tr>
<td>4 Versatile uniaxial bench top mechanical tester</td>
</tr>
<tr>
<td>5 In Vitro-indentation of bone to determine mechanical properties</td>
</tr>
<tr>
<td>6 Tensile Testing of Hair</td>
</tr>
<tr>
<td>7 Dental static and fatigue testing system</td>
</tr>
<tr>
<td>8 Static, Dynamic and Fatigue Test system for Orthopaedic</td>
</tr>
</tbody>
</table>

6. Research Areas

- Dr D Desai
  - Sound and vibration analysis
  - Stress analysis – structural dynamics
  - Coupled acoustic-structural analysis
  - Thermo-mechanical stress analysis
  - Infrared thermography
  - Numerical simulation
  - Characterization of dynamic properties of materials
  - Asset integrity management – fatigue life prediction, vibration and modelling
  - Biomechanics (in collaboration with Dr F Masithulela-UNISA)

7. Contact

Group leader: Dr D Desai
Tel: +27 (0)12 382 5886
Email: desaida@tut.ac.za

**Some topics are mentioned below to serve as guidelines but students are welcome to propose their own topic more or less in line with the above areas:**
1. Transient analysis of thermal bending and vibration of a turbine rotor with attached seals
2. Fatigue life prediction of mistuned steam turbine blades subjected to variations in blade geometry
3. Fatigue life prediction of steam turbine blades (variations in either damping or material properties...etc – a probabilistic approach.
4. Geometric optimisation of a boiler tube web fatigue member.
5. Prediction of transformer transport damage due to shock loading.
7. Prediction of damping characteristics of a self-actuating Z-lock integral shroud mechanism
8. Investigation of micro-mechanism of material fatigue resistance induced by shot peening process (continuation of current research activities at TUT).
9. Online monitoring of residual stresses during shot peening process (continuation of current research activities at TUT).
10. Prediction of damping characteristics on laced blade-disk assemblies using infrared thermography (continuation of current research activities at TUT).
11. Online prediction of vibration characteristics of turbomachinery using infrared vibrothermography (continuation of current research activities at TUT).
12. Optimisation of the blade shot peening process in terms of location.
13. Optimisation of the blade shot peening process in terms of material selection.
14. Vibrational characterisation of internal components (eg. turbine blades) using novel techniques (hybrid X-ray/Infrared...etc).
15. Modal analysis of a municipal power transmission pylon: prediction and validation
16. FEA modeling methodology for prediction of boiler wall fatigue failure
17. Precipitator plate vibration
18. Information harvesting from blade tip time of arrival measurements
19. Boiler tube localized flaw sensitivity specification
20. Fatigue life prediction of steam turbine blades – a probabilistic approach
21. Prediction of long term benefits of compressive residual stresses in turbine blade roots and rotor attachments
22. Turbine blade stress response due high shaft lateral vibration
23. Estimation of generator rotor lateral and torsional stiffness by 3D FEM
24. Generator end winding vibration
25. Vibration behaviour of transformers. Can vibration monitoring be used to assess transformer condition?
26. Development of a material model to account for cyclic hardening and softening
27. Prediction of residual stresses in steam turbine blade subjected to shotpeening.
28. Low cost FEA and prediction of torsional natural frequencies of rotors with bladed discs.
Refrigeration and Heat Pump Systems

This active research group strives to provide postgraduate education, training, research and development focusing on the energy efficiency and environmentally friendly refrigeration and heat pump systems driven by industrial needs. It therefore operates on the basis of postgraduate student projects, which are completed in partial or complete fulfilment of the requirements for a particular post-graduate degree. These projects are structured on a competency-based approach and promote excellence in accordance with the mission of the Tshwane University of Technology.

Thermal Energy systems are in essence energy transfer and conversion (transformation) systems that use fluids as the working substances based on the interrelated thermal sciences of thermodynamics, heat transfer and fluid dynamics. These systems play a crucial role in domestic, commercial, and industrial applications where there is a continuous demand for cheap, efficient, and reliable energy generation, conversion, transport, and storage.

Refrigeration and heat pump systems, the typical thermal energy systems, are energy efficiency systems and widely applied in sectors of domestic, commercial, and industrial applications, the energy consumption of refrigeration and heat pump systems is quite high and there is attractive potentials of improvement of energy efficiency of these systems, which will consequently positively contribute to the climate change and environmental improvement.

The main aim of the research group is to develop new technologies and systems of refrigeration and heap pump for domestic, commercial, and industrial applications.

The key research focus includes:

(1) Energy efficiency of refrigeration systems

Refrigeration plays a critical role on food security, safety, and quality, to meet the increasing demand of foods, most solutions are based on the increase of agricultural output, which is vital, but probably insufficient, the major focus should be on the reduction of post-harvest losses, which average about 25% of the food production worldwide. The produce loss can be dramatically minimised by introduction of the cold chain, from which considerable amount of energy is consumed by refrigeration facilities and the energy saving can be achieved from the refrigeration generation and the refrigeration utilization by enhancement of heat transfer, optimization of refrigeration system, minimization of heat loads, and maximization of usage of refrigeration.

The main facilities we are currently focus on include (1) Processing freezers and pre-coolers, (2) Refrigerated transport vehicles, (3) Cold rooms (frozen and chilled), and (4) Refrigerated display cabinets.
(2) Heat pump systems for heating, cooling, and drying

Heat pump system, in principle, is same as refrigeration system and can produce heat to the higher temperature sinks with multi-fold of the power supplied. The heat sources which can be used for heat supply are renewable energy from air, ground, and waste water sources. Solar energy can also be used in the heat pump systems as the assisted energy.

Our main activities focus on the development of higher energy efficient heat pump technologies for drying of biomaterials (including fruits and vegetables), space heating & cooling, and water heating based on South African condition.

(3) Natural alternative refrigerants

All Halocarbon refrigerants used in refrigeration and heat pump systems have the global warming potential (GWP) and/or ozone depletion potential (ODP), such as R12, R22, R134a, R404A, R502, etc. they are all just the intermediate refrigerants and will be phased out gradually. The natural working fluids are most promising substitutes to replace the ODP and GWP refrigerants.

We are working on the hydrocarbon substances (HCs) and Carbon Dioxide (CO2), whose ODP is zero and negligible GWP, to replace the Halocarbon refrigerants in domestic and commercial refrigeration systems and heat pump systems.

Services:

(1) Postgraduate study at master and doctoral levels,
(2) Postdoc research fellowship,
(3) Research, innovation, and development,
(4) Consultation.

Contact:

Zhongjie Huan (PhD, CEM, CMVP)

Professor: Department of Mechanical Engineering
Faculty of Engineering and the Built Environment
TSHWANE UNIVERSITY OF TECHNOLOGY (TUT)
E-mail: huanz@tut.ac.za
Tel: +27 (0)12 382 5386