Computer Aided Design Laboratory

The department of Mechanical Engineering is equipped with latest commercial software required for research and development. The department acquired licensed versions of finite element analysis ANSYS, Nastran-Algor, Catia, AutoCad, Star-CCM+ etc. A number of faculty and students have already made excellent use of these software for their research and a number of computational and analytical research projects based on the software are in progress. In addition to the CAD laboratory, the department also owns a computer lab equipped with AUTOCAD software to train students in computer aided design.

Stress Analysis Laboratory
This is an advanced laboratory used for training M.Tech and Ph.D level students in the field of Vibration Analysis and Condition Monitoring. The concept of condition monitoring has been a vital feature in the maintenance of machinery of critical nature. Various condition-monitoring approaches have been utilized in the detection of machinery faults and damage identification of mechanical systems using optimization strategies.

The stress analysis lab provides the equipment needed for such studies. One significant piece of equipment present in the laboratory is a laser Doppler vibrometer that can be used to detect the vibrations of rotating parts using a non-contact laser technique. The equipment has been an integral part of the project titled, “Damage identification of mechanical systems using optimization strategies” awarded by the DST. The equipment also consists of a built in data acquisition software which can directly calculate the dynamic characteristics of the system based on the acquired data. The device serves as a measurement system for single point frequency analysis upto 20 kHz. Any change of response in the system can be detected using the vibrometer which alerts the user of the deterioration or damage of the equipment.

The stress analysis laboratory also consists of a photoelastic bench which is used to study the stresses and strains experienced by the material using an optical technique. This equipment has been in use for the design and analysis of various machine parts in contact. This equipment is primarily used as a teaching aid to the students along with several other equipment such as spring-mass systems for the study of vibrations.

The list of experiments to be performed by the students is:

- Measurement of strain by using strain gauges
- Calibration of Rotameter
- Calibration of Thermocouples
- Experiment with constant voltage/current hot-wire anemometer
- Experiments with piezo-electric pickup and inductive pickups
- Experimental determination of undamped and damped frequencies of spring mass system
- Ultrasonic flaw detector
- Experiment on photoelastic bench (Plain and Circular Polariscope)
- Photoelastic analysis of disc under diametric compression / ring under diametric compression

Heat and Mass Transfer Laboratory

The field of heat and mass transfer has been eminent area of research at the Department of Mechanical Engineering with several studies having been conducted in the field.
Research projects such as “Heat Transfer Studies on Automotive Coolants” funded by HPCL, “Heat Transfer Studies on Coolants in Military Vehicle Engines”, “Evaluation of Heat Transfer and other Transport Characteristics of Nano Fluids in Circular Tubes”, and “Estimation of Transient and Steady State Temperature Distribution in Turbine Rotor Blades” funded by DRDO have been the most recent studies in the field.

The laboratory of heat and mass transfer consists of equipment for the measurement of thermal conductivity, convective and radiation behavior of different types of materials and objects in various conditions. The study of heat exchangers is also a part of this laboratory where heat transfer rate of different types of flows can be measured. Study of air conditioning equipment is also available along with equipment for the measurement of temperature and pressure variations during different types of fluid flows. The laboratory is also open to students and helps them in familiarizing with the field of heat transfer. The equipment available in this laboratory is listed below.

1) **CRITICAL HEAT FLUX APPARATUS**

-To study the formation of bubbles under pool boiling process and to draw the graph of heat flux Vs bulk temperature up to burnout (critical value) condition.

**Technical Specifications:**

1. **Cylindrical Shell**  
   a) Diameter : 200mm (Approx.)  
   b) Height : 300mm (Approx.)  
   c) Material : Glass

2. **Immersion Heaters**  
   a) Capacity : 1KW

3. **Measuring Instruments**  
   a) Digital Voltmeter, Range : 0 to 300 V
   b) Digital Ammeter, Range : 0 to 10Amps
   c) Digital Temp. Indicator with Selector Switch
: Ambient to 199.9 deg.c.

4. Thermocouples
   a) Type
      : Cr.Al.
   b) Length
      : 1 Mtr

5. Dimmerstat
   a) Range
      : 0 to 220 volts Ac
   b) Make
      : BHARAT/S TD

   Overall Dimension: 32” × 22” × 42” (L × B × H, approx)

2) HEAT PIPE DEMONSTRATOR

   - To conduct test on a heat pipe and compare the temperature distribution and rate of heat transfer with geometrically similar copper and stainless steel tubes.

   Technical Specifications:

1. Heat Pipe
   a) Diameter
      : 25mm (Approx.)
   b) Height
      : 300mm (Approx.)
   c) Material
      : Brass

2. Test Pipes
   a) Diameter
      : 25mm (Approx.)
   b) Height
      : 300mm (Approx.)
   c) Material
      : Copper
   d) Diameter
      : 25mm (Approx.)
   e) Height
300mm
(Approx.)
f) Material
   : S.S.
3. Cooling Jackets
   a) Size
      : 150 x 100 x 50mm(Approx.)
   b) Material
      : S.S.
   c) Quantity
      : 3 Nos.
4. Measuring Instruments
   a) Digital Voltmeter, Range
      : 0 to 300 V
   b) Digital Ammeter, Range
      : 0 to 10Amps
   c) Digital Temp. Indicator with
      Selector
      Switch
      : Ambient to 199.9 deg.c.
5. Thermocouples
   a) Type
      : Cr.Al.
   b) Length
      : 1 Mtr
6. Dimmerstat
   a) Range
      : 0 to 220 volts
   b) Make
      : BHARAT/ST D

Overall Dimension: 36” × 26” × 42” (L × B × H, approx)

3) THERMAL CONDUCTIVITY BY GUARDED HOT PLATE (SOLID)

-To study the thermal conductivity by guarded hot plate.
Technical Specifications:

1. Guarded plate section
   a) Main Heater Plate
      b) Diameter : 90mm
      c) Material : Brass
   d) Ring Heater Diameter : 100 ID / 150 OD mm
      e) Material : MICA
   f) Ring Heater Plate
      Diameter 100 ID / 150 OD mm
      g) Material : Brass
   h) Asbestos plate
      mm thick 150 ID / 12
   i) Cooling jacket
      Diameter 150 OD
      j) Material : Brass
      k) Size : 12mm thick

2. Measuring Instruments
   d) Digital Voltmeter, Range : 0 to 300 V
   e) Digital Ammeter, Range : 0 to 5Amps
   f) Digital Temp. Indicator with Selector : Ambient to 199.9 deg.c.

3. Thermocouples
   c) Type : Cr.Al
   d) Length : 1 Mtr

4. Dimmerstat
   c) Range : 0 to 220 volts
Overall Dimension: 32” × 22” × 50” (L × B × H, approx)

4) THERMAL CONDUCTIVITY OF LIQUID

- To study the thermal conductivity of liquid.

Technical Specifications:

1. Specimen Specification
   a) Diameter of pipe : 100mm
   b) Material       : Brass
   c) Length        : 40mm
   d) Heater

   Diameter : 100mm mica
   
   e) Cooling Plate

   Diameter : 100mm (Approx.)
   
   f) Thickness of liquid : 40mm

2. Measuring Instruments
   a) Digital Voltmeter,
      Range      : 0 to 300 V
   b) Digital Ammeter,
      Range      : 0 to 10Amps
   c) Digital Temp.
      Indicator with Selector
      Switch
3. Thermocouples
   a) Type
      : Cr.Al.
   b) Length
      : 1 Mtr

4. Dimmerstat
   a) Range
      : 0 to 220 volts Ac
   b) Make
      : BHARAT/STD

   Overall Dimension: 32” × 22” × 50” (L × B × H, approx)

5) **HEAT TRANSFER IN NATURAL CONVECTION**

   - To study the heat transfer co-efficient of vertical cylinder and to compare with experimental valve.

   **Technical Specifications:**

1. S.S. Cylindrical tube
   a) Diameter
      : 40mm
   b) Length
      : 400mm

2. Measuring Instruments
   a) Digital Voltmeter,
      Range : 0 to 300 V
   b) Digital Ammeter,
      Range : 0 to 10Amps
   c) Digital Temp. Indicator with Selector Switch:
      Ambient to 199.9 deg.c.
3. Thermocouples
   a) Type : Cr.Al.
   b) Length : 1 Mtr
4. Dimmerstat
   a) Range : 0 to 220 volts Ac
   b) Make : BHARAT/STD

Overall Dimension: 32” × 22” × 48” (L × B × H, approx)

6) PLATE TYPE HEAT EXCHANGER

-To determine the overall heat transfer co-efficient and heat exchanger effectiveness.

*Technical Specifications:*

1. Plate
   a) Diameter : 15cms
   b) length : 30cms
   c) Material : S.S
   d) Number of plate : 5Nos.
2. Hot water geyser
   a) Capacity : 1Litre
   b) Heater : 3 KW
3. Digital temperature indicator
   a) No. of Digits : 4 digits
   b) Range : Ambient to 200 deg.c.
   c) Resolution : 
1. Glass Tube
   a) Diameter : 90mm OD (Approx.)
   b) Height : 275mm (Approx.)
   c) Quantity : 1 No.

2. Measuring Instruments
   a) Digital Temp. Indicator with Selector Switch : Ambient to 199.9 deg.c.

3. Thermocouples
   a) Type : Cr.Al.
   b) Length : 1 Mtr

4. Rotameter
   a) Material : Acrylic
   b) Range : 0 to 60 cc/sec

5. Steam Generator
   a) Diameter : 200mm (Approx.)
   b) Height : 300mm (Approx.)
   c) Material : M.S.
   d) Heater used : 2 KW / 1 No.

Overall Dimension: 32” × 22” × 50” ((L × B × H, approx)

7) DROP & FILMWISE CONDENSATION APPARATUS

-To study the drop and film phenomena.

Technical Specifications:

- Glass Tube:
  a) Diameter: 90mm OD (Approx.)
  b) Height: 275mm (Approx.)
  c) Quantity: 1 No.

- Measuring Instruments:
  a) Digital Temp. Indicator with Selector Switch: Ambient to 199.9 deg.c.

- Thermocouples:
  a) Type: Cr.Al.
  b) Length: 1 Mtr

- Rotameter:
  a) Material: Acrylic
  b) Range: 0 to 60 cc/sec

- Steam Generator:
  a) Diameter: 200mm (Approx.)
  b) Height: 300mm (Approx.)
  c) Material: M.S.
  d) Heater used: 2 KW / 1 No.

Overall Dimension: 32” × 22” × 50” ((L × B × H, approx)
8) FLUID BED HEAT TRANSFER UNIT

Technical Specifications:

1. Glass Column
   a) Diameter : 60mm
   b) Height : 600mm

2. Geyser
   a) Capacity : 3 KW
   b) Make : Recoid / Equivalent

3. Rotameter
   a) Make : TTE
   b) Quantity : 1 Nos.
   c) Material : Acrylic

4. Centrifugal Pump
   a) Make : Lubi / Equivalent
   b) HP : 0.5 HP

5. Water tanks
   a) Size : 300 x 300 x 500 mm
   b) Guage : 18 Swg
   c) Qty : 1 No.
   d) Material : Stainless Steel

6. Temperature Indicator
   a) Range : 0 to 199.9° C
   b) Type : Digital

7. Thermocouples
   a) Type : Cr-Al
   b) Qty : 12Nos.

Overall Dimension: 1.0 x 0.7 x 1.8m (L x B x H, approx)

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Mechanical Engineering - I laboratory

This laboratory provides basic introduction to students into the field of Mechanical Engineering experimentation. The students perform experiments on basic Mechanical Engineering apparatus. The list of experiments to be performed in this laboratory is given below.

<table>
<thead>
<tr>
<th>Name of the study</th>
<th>Name of the Equipment</th>
</tr>
</thead>
</table>

| To study the variation of kinematic viscosity of given oil samples with temperature | • Redwood Viscometer – I (low speed)  
• Redwood Viscometer – II (high speed) |
|---|---|
| To draw port timing diagrams on two stroke engines. | • 2-stroke diesel engine  
• 2-stroke petrol engine |
| To draw valve timing diagrams on four stroke engines. | • 4-stroke diesel engine  
• 4-stroke petrol engine |
| To measure heat capacity of various substances. | • Bomb Calorimeter  
• Junkers Calorimeter |
| To measure the flash point of oil samples. | • Pensky Marten flash point apparatus. |
| To measure the flash and fire points of oil samples | • Cleaveland’s open cup apparatus for fire and flash point measurement. |
| To calculate the moment of inertia. | • Flywheel model |
| To calculate acceleration due to gravity. | • Compound pendulum model |
| To calculate Modulus of Rigidity. | • Torsional Pendulum model |
| To perform pressure measurements. | • Dead weight pressure gauge model |

The laboratory also houses equipment used for research purposes. Some of the equipment used is:

- Cloud and pour point apparatus
- Rotating pressure vessel oxidation stability test apparatus
- Copper strip corrosion bath
- Boiling point apparatus
The study of engines and the development of environmental friendly, fuel efficient, performance oriented engines for automotive and industrial applications is a primary area of interest in the field of mechanical engineering. This laboratory boasts of the latest internal combustion engines for research and academic purposes. The APEX Computerized Engine Test Rig, UNI-INST Variable Compression, Eddy Current Dynamometer, 3-Cylinder, 4-Stroke Maruti 800 Engine with Eddy Current Dynamometer, Computerized research engine setup with Eddy Current dynamometer help in the study of engine performance at various operating conditions. The laboratory also consists of other equipment such as a vapor compression test rig, two-stage reciprocating air compressor, blower test rig, dynamic balancing machine etc where studies on coefficient of performance, gyroscopic effect etc can be performed.
Apart from academic training, the laboratory serves as an important research facility where different types of oils are tested for their performance. Another important piece of equipment that complements the engines is the 5-gas analyzer. The 5-gas analyzer is used to test the composition of exhaust fumes. This is particularly effective in the analysis of engine lubricants and fuels. Owing to the strict emission regulations and the need for enhancement of biodegradable and environmental friendly fuels, research is aimed at the study of nano-additives in fuels and lubricants. The department had already been granted a project by the Department of Science and Technology (DST) for the development of eco-friendly biodiesel blends which is to start soon. This project includes the procurement of further engine testing and analysis equipment. The major equipment available in this laboratory is listed below.

1) **Single Cylinder Four Stroke , Computerized Diesel Engine Test Rig**
   (Apex Innovation Pvt Ltd, Sangli)
   - To calculate the performance at constant speed and also heat balance test.

   **Specification**
   Engine, (Kirloskar oil engine Ltd, Pune)
   No. of Cylinder : 1
   No. of Strokes : 4
   Fuel : high speed diesel
   Rated Power : 5.2 KW @ 1500 RPM
   Cylinder Diameter : 87.5mm
   Stroke Length : 110mm
   Compression Ratio : 17.5:1
   Orifice diameter : 20mm
   Dynamometer arm length : 185mm

2) **Computerized Variable Compression Multi fuel Research Engine**
   (Apex Innovation Pvt Ltd, Sangli)
-To conduct the performance test using Petrol
-To conduct the performance test using Diesel

**Specification**
Engine, (Kirloskar oil engine Ltd, Pune)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Fuel (Diesel)</th>
<th>Fuel (Petrol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Cylinder</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>No. of Strokes</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Cylinder Diameter</td>
<td>87.5mm</td>
<td>87.5mm</td>
</tr>
<tr>
<td>Stroke Length</td>
<td>110mm</td>
<td>110mm</td>
</tr>
<tr>
<td>Connecting Rod length</td>
<td>234mm</td>
<td>234mm</td>
</tr>
<tr>
<td>Orifice diameter</td>
<td>20mm</td>
<td>20mm</td>
</tr>
<tr>
<td>Dynamometer arm length</td>
<td>185mm</td>
<td>185mm</td>
</tr>
<tr>
<td>Power</td>
<td>3.5KW</td>
<td>4.5KW</td>
</tr>
<tr>
<td>Speed</td>
<td>1500 RPM</td>
<td>1200-1800</td>
</tr>
<tr>
<td>C.R.Range</td>
<td>12:1 to 18:1</td>
<td>6:1 to 10:1</td>
</tr>
<tr>
<td>Injection point variation</td>
<td>0 to 25° BTDC</td>
<td>0 to 70° BTDC</td>
</tr>
</tbody>
</table>

3) **Multi Cylinder Four Stroke Petrol Engine (Maruti Suzuki)**
(Apex Innovation Pvt Ltd, Sangli)

- To conduct Morse test
- To conduct Heat balance Test

**Specification**
Engine, (Maruthi 800)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Fuel (Diesel)</th>
<th>Fuel (Petrol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Cylinder</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>
No. of Strokes : 4
Fuel : Petrol
Rated Power : 27.6 KW @ 5000 RPM
Cylinder Diameter : 66.5mm
Stroke Length : 72.0mm
Compression Ratio : 9.2:1
Connecting rod length : 114mm
Orifice diameter : 35mm
Dynamometer arm length : 210mm

4) **Two Stage Reciprocating Air Compressor Test Rig**
   (Universal Instruments, Bangalore)

   -To conduct the performance Test

   **Specification**
   Orifice diameter : 20mm
   Stroke Length : 113mm
   Diameter of H.P. Cylinder : 90mm
   Diameter of L.P. Cylinder : 110mm
   Spring Index
   a) L.P. Cylinder (K1) : 0.8 Kgf/Cm²/Cm
   b) H.P. Cylinder (K2) : 5 Kgf/Cm²/Cm
   Speed Compressor : 400 RPM

   **Motor**
   AC Motor, 75HP
   1440 RPM
   3 Phases
   440 Volts

5) **Variable Compressor Single Cylinder Four Stroke Petrol Engine**
   (Universal Instruments, Bangalore)
To conduct the performance Test and heat balance test

**Specification**
(Greaves-MK-25)

<table>
<thead>
<tr>
<th>No. of Cylinder</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of Strokes</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B.H.P</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bore</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>70mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stroke Length</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>66.7mm</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Compression Ratio variable</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:1 to 2.5:1</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normal Compression Ratio</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.67</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RPM</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2800</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Loading</th>
<th>:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eddy Current Dynamometer</td>
<td></td>
</tr>
</tbody>
</table>

6) **Vapour Compression Refrigeration Test Rig Unit**

-To calculate C.O.P of Refrigeration test rig

**Specification**

1. Vapour compression refrigerator with air cooled condenser
2. Compressor is axial flow compressor
3. Two energy meters are provided to measure the power supply to the compressor and fan
4. Fan is provided in the condenser for cooling
5. System is provided with two types of the throttling valve
   a) Capillary tube
   b) Solenoid Valve
Nanotechnology Research Lab

The field of nanotechnology is one of the fastest growing fields of research with unlimited scope for invention. The department of Mechanical Engineering strives to keep abreast with all the leading researchers in the field of nanotechnology. As such, it has established a special laboratory for nanotechnology applications in Mechanical Engineering and has acquired state of the art research equipment. Efforts are being made for the procurement of more equipment in collaboration with various national defense laboratories and research institutes.

This laboratory contains some of the equipment like ultrasonic sonicator for dispersion of nanoparticles in oils, engine test rigs to test the effectiveness of various lubricants and fuels, pin-on-disc apparatus for studying the friction and wear characteristics of lubricants on metals, metallurgical microscope for analyzing samples at micro and nano level etc. High Energy Ball Mill, which is used in the preparation of nano-powders from powders containing micro level sized particles, also exists within the laboratory. 4-ball wear tester and Pin on Disc tribometer setup used to measure tribological quantities such as coefficient of friction, friction force, and wear volume, between two surfaces in contact are also part of the lab. These are mostly being used for the study of micro and nano level coatings that are being used to improve the performance of IC engines and also to evaluate lubricant characteristics of oils with addition of nano powders. The laboratory also boasts of various other pieces of equipment such as ovens, hardness testers, adhesion testers etc. In addition to the facilities listed above, the University also provides X-Ray Diffraction and supercomputing facilities for research.

The research laboratory facilities has aided in a number of successful projects such as “Effect of nano particle inclusion on the lubricating properties of lubricants” (for HPCL). Projects titled, “Development of Coatings based on Nano Technology for IC engine applications” (VRDE, DRDO), “Heat Transfer Studies on Automotive Coolants” (for HPCL) and “Application of Nano Particle Additive Dispersion Lubricants in Automotive Engine Systems” (for HPCL) are currently in progress.

4 BALL TESTER - TR 30H
The Ducom four ball tester is an excellent development and quality check tool for lubricating oils, greases and additives. Its purpose is to test wear preventive (WP), extreme pressure (EP) and fatigue properties of lubricants and cutting fluids. It is an excellent tool to aid research and development of new lubricating products and also as a quality control tool for both manufacturers of lubricants and buyers of large quantities of lubricants.

The unique test specimen geometry and arrangement make the system self-aligning and creates a very repeatable "point contact" every time. This ability to generate a repeatable contact is one of the reasons that the Four Ball Tester generates results that are consistent and therefore used widely for reporting a lubricant’s wear and friction performance. The test results are further improved by tightly controlling test specimens and test setup procedures.

Since its development, the Four Ball Tester is as an additive manufacturer to develop and fine tune their additives to achieve the desired wear and friction modulation behavior. It is used as a lubricant manufacturer (oil and grease) to formulate better lubricants as well as to benchmark performances of the products. Industries that are large scale consumers of lubricants, especially in applications where lubricant performance is critical to machinery operation and end product finish use the Four Ball Tester to maintain a check on the incoming quality of lubricants.

The system is capable of conducting:

- Wear preventive (WP)/ Anti wear (AW) tests
- Extreme pressure (EP) tests.
- Friction tests
- Shear stability tests
- And also other custom tests (elevated temperature, ball on three disks, thrust washer etc…)

The Ducom Four Ball Tester is capable of performing tests in accordance with ASTM standards D2783, D2596, D2266, D4172 and D5183 and also IP 239, IP 300, DIN 51350-6 and CEC L-45-5-93.

The Ducom Four Ball Tester comes with data acquisition software, WinDucom, to present data in a variety of ways. The Compariview tool allows the user to compare and evaluate the test results. Wear scar readings can be conveniently evaluated using an image acquisition system that comes along with the ScarView software.
**Specifications:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>RPM</td>
<td>1000</td>
<td>3000</td>
</tr>
<tr>
<td>Maximum axial load</td>
<td>N</td>
<td></td>
<td>10,000</td>
</tr>
<tr>
<td>Temperature</td>
<td>Deg C</td>
<td>Ambient</td>
<td>100</td>
</tr>
<tr>
<td>Test ball diameter</td>
<td>mm</td>
<td></td>
<td>12.7</td>
</tr>
<tr>
<td>Scar Image</td>
<td>Micron</td>
<td>100</td>
<td>4000</td>
</tr>
</tbody>
</table>

**WEAR & FRICTION MONITOR - TR 201**

The Ducom Wear and Friction Monitor – TR 201 Series is the industry standard in wear and friction analysis. The TR 201 Series tribometer is specifically designed for fundamental wear and friction characterization. This instrument consists of a rotating Disk against which a test pin is pressed with a known force. A provision for measurement of compound wear and frictional force is provided.

The TR 201 Series comes with the WinDucom software for data acquisition and display of results. WinDucom software is used to present data in a variety of ways and CompariView provides a powerful tool to view and compare test results for evaluation.

- RPM
- Wear
- Frictional force
- Temperature (optional)

Using the WinDucom Data Acquisition System, a PC acquires test data online and displays it in several ways. Graphs of individual tests can be printed. Results of different tests can be superimposed using the WinDucom CompariView.
Inverted Metallurgical Microscope - GX51

The GX51 inverted microscope provides stability to support excellent image clarity and superb resolution with high magnifications and comfortable operability with the option to add many accessories including digital cameras, coded revolving nosepieces and software solutions. Its features include:

- Ergonomics and Efficiency
- Ease and Comfort Operation
- Enhanced Efficiency Through Motorization
- Excellent Image Clarity and Superb Resolution
- Wide Variety of Choices for Superior Imaging Performance

**Specifications:**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Unit</th>
<th>Min</th>
<th>Max</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin size (diameter or diagonal)</td>
<td>mm</td>
<td>2</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Ball diameter (holders)</td>
<td>mm</td>
<td>10</td>
<td></td>
<td>With different</td>
</tr>
<tr>
<td>Disc Size</td>
<td>mm</td>
<td></td>
<td>100x6</td>
<td></td>
</tr>
<tr>
<td>Wear Track Diameter (RPM)</td>
<td>mm</td>
<td>20</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Disc Rotation</td>
<td>RPM</td>
<td>80</td>
<td>800</td>
<td>(Stage Stationary Type)</td>
</tr>
<tr>
<td>Normal Load</td>
<td>N</td>
<td>0</td>
<td>100</td>
<td>In steps of 5 N</td>
</tr>
</tbody>
</table>

**Optical System:**

- **UIS2 Optical System (Infinity-corrected)**
  - Reflected Light: 100 W Halogen/100 W Mercury/75 W Xenon
  - Transmitted Light: 100 W Halogen

**Focus:**

- Motorized/Manual: Revolving Nosepiece Up/Down Movement (Stage Stationary Type)
- Stroke: 9 mm
- Resolution/Fine Adjustment Sensitivity: Fine Stroke per Rotation 0.1 mm

**Stage:**

- Stroke: 50(X) x 50(Y) mm
Well's Brookefield Cone and Plate Viscometer

Well's Brookefield Cone and Plate Viscometer is a compact, heavy-duty instrument that is ideal for fast, easy, repetitive testing with a small sample size and integrated temperature control built into the sample plate.

Features and Benefits

- **Determine absolute viscosity** of small samples (0.5 – 2.0 mL)
- **Available in these models**
  - DV3T Rheometer
  - DV2T Viscometer
  - DV-I Prime Viscometer
- **Accuracy:** ±1.0% of range
- **Repeatability:** ±0.2%
- **Electronic Gap Adjustment™**
  - Simplified setup
  - Accurate
  - Easy-to-use
- **RTD Temperature Sensor** in Sample Cup (Optional)
  provides direct measurement of sample temperature
  Meets Industry Standards:
  - [ASTM D4287](#)
  - [ISO 2884](#)
  - [BS 3900](#)
- **Rugged Design Can Handle Production Environment**
- **Rugged design can handle production environment**
Planetary Ball Mill

A ball mill is a type of grinder used to grind materials into extremely fine powder for use in mineral dressing processes, paints, pyrotechnics, and ceramics. Planetary ball mills are smaller than common ball mills and mainly used in laboratories for grinding sample material down to very small sizes. A planetary ball mill consists of at least one grinding jar which is arranged eccentrically on a so-called sun wheel. The direction of movement of the sun wheel is opposite to that of the grinding jars (ratio: 1:-2 or 1:-1 or else). The grinding balls in the grinding jars are subjected to superimposed rotational movements, the so-called Coriolis forces. The difference in speeds between the balls and grinding jars produces an interaction between frictional and impact forces, which releases high dynamic energies. The interplay between these forces produces the high and very effective degree of size reduction of the planetary ball mill.

Grinding is carried out by high-energy frequent impact of balls. The energy level of balls are as high as $50 \text{ times}$ (at 400 r.p.m.) the gravitational acceleration. Thus, planetary system makes grinding extremely fast and efficient.

Rotation of base plate provides the centrifugal force to the grinding balls and independent rotation of bowls (in opposite direction) makes the balls to hit the inner wall of the bowls several times more, because of the short returned path. Since the bowls are rotating in opposite direction a considerable part of grinding is done due to friction.