



Republic of the Philippines
 TARLAC STATE UNIVERSITY
BIDS AND AWARDS COMMITTEE
GOODS AND SERVICES
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May 17, 2024

SUPPLEMENTAL BID BULLETIN NO. 2

Project: Supply, Delivery, and Installation of Laboratory Equipment for CE and ME of the College of Engineering (APP 2024)

This Supplemental Bid Bulletin No. 2 is issued to clarify items, modify of amend items in the bidding documents. Accordingly, this shall be an integral part of the said Documents.

Please be informed of the modifications in the Bidding Documents

Posted to PhilGEPS	Modifications																																								
<p style="text-align: center;">Section II. Instruction to Bidders</p> <p>19.4. The Project shall be awarded as one project having several items that shall be awarded as one contract.</p>	<p style="text-align: center;">Section II. Instruction to Bidders</p> <p>19.4. The Project shall be awarded as one project having several items that shall be awarded per item as separate contracts.</p>																																								
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<p style="text-align: center;">Invitation to Bid /Bid Data Sheet</p> <p>1. The Tarlac State University, through Regular Agency Fund (RAF) and Special Fund (SB) 2024 intends to apply the sum of Forty Two Million Four Hundred Ten Thousand Five Hundred Pesos 42,410,500.00 to payments under the contracts for the project: Supply, Delivery, and Installation of Laboratory Equipment for CE & ME of the College of Engineering (APP 2024). Bids received in excess of the ABC shall be automatically rejected at bid opening.</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th>Item No.</th> <th>Description</th> <th>Qty.</th> <th>Unit</th> <th>ABC, ₱</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">3.</td> <td>Test Stand for Single-Cylinder Engines, 3 kW</td> <td style="text-align: center;">1</td> <td style="text-align: center;">set</td> <td style="text-align: right;">2970000.00</td> </tr> <tr> <td style="text-align: center;">14.</td> <td>Apparatus, General Purpose Drying Oven</td> <td style="text-align: center;">2</td> <td style="text-align: center;">set</td> <td style="text-align: right;">160,000.00</td> </tr> <tr> <td style="text-align: center;">15.</td> <td>Vortex Apparatus</td> <td style="text-align: center;">3</td> <td style="text-align: center;">set</td> <td style="text-align: right;">255,000.00</td> </tr> </tbody> </table>	Item No.	Description	Qty.	Unit	ABC, ₱	3.	Test Stand for Single-Cylinder Engines, 3 kW	1	set	2970000.00	14.	Apparatus, General Purpose Drying Oven	2	set	160,000.00	15.	Vortex Apparatus	3	set	255,000.00	<p style="text-align: center;">Invitation to Bid /Bid Data Sheet</p> <p>1. The Tarlac State University, through Regular Agency Fund (RAF) and Special Fund (SB) 2024 intends to apply the sum of Forty Two Million Four Hundred Ten Thousand Five Hundred Pesos 42,410,500.00 to payments under the contracts for the project: Supply, Delivery, and Installation of Laboratory Equipment for CE & ME of the College of Engineering (APP 2024). Bids received in excess of the ABC shall be automatically rejected at bid opening.</p> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th>Item No.</th> <th>Description</th> <th>Qty.</th> <th>Unit</th> <th>ABC, ₱</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">3.</td> <td>Test Stand for Single-Cylinder Engines, 3 kW</td> <td style="text-align: center;">1</td> <td style="text-align: center;">set</td> <td style="text-align: right;">13,470,000.00</td> </tr> <tr> <td style="text-align: center;">14.</td> <td>Apparatus, General Purpose Drying Oven</td> <td style="text-align: center;">1</td> <td style="text-align: center;">set</td> <td style="text-align: right;">160,000.00</td> </tr> <tr> <td style="text-align: center;">15.</td> <td>Vortex Apparatus</td> <td style="text-align: center;">1</td> <td style="text-align: center;">set</td> <td style="text-align: right;">255,000.00</td> </tr> </tbody> </table>	Item No.	Description	Qty.	Unit	ABC, ₱	3.	Test Stand for Single-Cylinder Engines, 3 kW	1	set	13,470,000.00	14.	Apparatus, General Purpose Drying Oven	1	set	160,000.00	15.	Vortex Apparatus	1	set	255,000.00
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Specification

- Supply unit for heat exchangers
- Hot water circuit with tank, heater, temperature controller, pump, and protection against lack of water
- Cold water circuit from laboratory water supply
- Temperature controller controls the temperature of hot water
- Flow adjustable using valves
- Digital displays for 6 temperature and 2 flow rate sensors
- Water connections with quick-release couplings
- Stirring machine connection with speed adjustment
- Software for data acquisition via USB under Windows 7, 8.1, 10

Technical data:

Pump: power consumption of at least 120W, max. flow rate of at least 600L/h and max. head of 30m

Heater: power output of not more than 3kW, thermostat setting from 0 to 70°C Hot water tank: approx. 10L

Specification:

- Shell and tube heat exchanger (cross-flow) for connection to Heat Exchanger Test Bench
- Hot and cold-water supply from Heat Exchanger Test Bench
- Cross parallel flow and cross counter flow operation possible
- Transparent shell, visible tube bundle
- Tube bundle consisting of at least 7 tubes and 4 baffle plates
- Recording of temperature using Heat Exchanger Test Bench

Technical data:

Heat transfer surface of 200cm²

Tube bundle, stainless steel with outer diameter of 6mm and wall thickness of at least 1mm

Shell, transparent (PMMA) with outer diameter of 50mm and wall thickness of at least 3mm ""

Accessory 1: Universal Drive and Brake Unit

Specification:

- Drive and brake unit used for studying different driving or driven machines - Asynchronous motor with frequency converter allows 4-quadrant operation: generator or motor mode
- Asynchronous motor with pendulum suspension, torque measurement via lever arm and force sensor
- Optical sensor for recording the speed
- Data exchange between base module and accessories through data cable
- Measured values for speed and torque are digitally displayed on the device Technical data:

Asynchronous motor with frequency converter

- power: at least 2200W
- maximum speed: approximately

Specifications:

- Supply unit for heat exchangers
- Hot water circuit with tank, heater, temperature controller, pump and protection against lack of water
- Cold water circuit from laboratory water supply
- Temperature controller controls the temperature of hot water
- Flow adjustable using valves
- Digital displays for 6 temperature and 2 flow rate sensors
- Water connections with quick-release couplings
- Stirring machine connection with speed adjustment
- Software for data acquisition via USB under Windows 7, 8.1, 10

Technical data:

Pump: power consumption of at least 120W, max. flow rate of at least 600L/h and max. head of 30m

Heater: power output of not more than 3kW, thermostat setting from 0 to 70°C Hot water tank: approx. 10L

Measuring ranges:

- Temperature: 6 x 0 to 100°C
- flow rate: 2 x 20 to 250L/h

Power requirement: 230V, 60Hz, 1 phase

Accessory: Tubular heat exchanger

Transparent heat exchanger with additional temperature measuring point after half of the transfer section; parallel flow and counterflow operation

List of experiments:

- Function and behavior during operation in parallel and counter flow
- Plotting temperature curves during operation in parallel and counter flow
- Calculation of mean heat transfer coefficient

- Comparison with other heat exchanger types

Specifications:

- Tubular heat exchanger for connection to the Heat Exchanger Test Bench
- Hot and cold-water supply from Heat Exchanger Test Bench
- Parallel flow and counterflow operation possible
- Recording of temperature using Heat Exchanger Test Bench and two additional temperature sensors for measuring the central temperature

Technical data:

Heat transfer surfaces: mean transfer surface of 250cm²

Inner tube, stainless steel with outer diameter of 12mm and wall thickness of 1mm

Outer tube, transparent (PMMA) with outer diameter of 20mm and wall thickness of: 2mm

Measuring ranges: temperature of 2 x 0 to 100°C

Accessory: Shell & tube heat exchanger

Transparent shell and tube heat exchanger in cross parallel flow and cross counterflow operation

<p>3000 rpm</p> <ul style="list-style-type: none"> - maximum torque: approximately 12Nm <p>'V-belt operation</p> <ul style="list-style-type: none"> - length of V-belt: 1157mm, 1180mm, 1250mm - type of V-belt: SPA - diameter of V-belt pulley: 125mm <p>Resistive load: 72Ω, 2400W</p> <p>Measuring ranges</p> <ul style="list-style-type: none"> - torque: ±15Nm - speed: 0 to 5000 rpm <p>Power requirement: 230V, 60Hz, 3 phases"</p> <p>"Accessory 2: Four-stroke Gasoline Engine</p> <p>Air-cooled overhead valve four-stroke petrol engine</p> <p>Specification:</p> <ul style="list-style-type: none"> - Air-cooled single-cylinder four-stroke petrol engine for installation in the Engine Test Stand - Engine mounted on vibration-insulated base plate - Force transmission to brake via pulley - Engine complete with fuel hose and exhaust gas temperature sensor - Fuel hose with self-sealing quick-release coupling <p>Technical data : Air-cooled single-cylinder petrol engine - power output: approximately 2.2kW at 3200 rpm</p> <ul style="list-style-type: none"> - bore: 62mm - stroke: 42mm <p>Belt pulley: Ø 125mm"</p> <p>"Accessory 3: Pressure transducer and TDC sensor for Four Stroke Gasoline Engine</p> <p>Modified spark plug with piezoelectric pressure sensor</p> <p>Specification:</p> <ul style="list-style-type: none"> - Modified spark plug carrying the actual pressure transducer - Quartz pressure transducer <p>Technical data: Pressure transducer</p> <ul style="list-style-type: none"> - measuring range: 0 to 100bar - maximum operating temperature: at least 200°C - maximum allowable pressure: at least 250bar" <p>Accessory 4: Four-stroke diesel engine</p> <p>Air-cooled four-stroke diesel engine with direct injection</p> <p>'Specification:</p> <ul style="list-style-type: none"> - Air-cooled single-cylinder four-stroke diesel engine for for installation in the Engine Test Stand - Engine mounted on vibration-insulated base plate - Force transmission to brake via pulley - Engine complete with fuel hose and exhaust gas temperature sensor - Fuel hose with self-sealing quick-release coupling <p>Technical data :</p> <p>Air-cooled single-cylinder diesel engine</p> <ul style="list-style-type: none"> - power output: approximately 3kW at 3000rpm - bore: 69mm - stroke: 62mm <p>V-belt: Ø 125mm "</p> <p>"Accessory 5: Pressure transducer and TDC sensor for Four Stroke Diesel Engine</p> <p>Pressure measurement in the combustion chamber of an engine using a micro pressure transducer</p>	<p>List of experiments:</p> <ul style="list-style-type: none"> - Function and behavior during operation in parallel and counter flow - Plotting temperature curves during operation in parallel and counter flow - Calculation of mean heat transfer coefficient - Comparison with other heat exchanger types <p>Specifications:</p> <ul style="list-style-type: none"> - Shell and tube heat exchanger (cross-flow) for connection to Heat Exchanger Test Bench - Hot and cold-water supply from Heat Exchanger Test Bench - Cross parallel flow and cross counter flow operation possible - Transparent shell, visible tube bundle - Tube bundle consisting of at least 7 tubes and 4 baffle plates - Recording of temperature using Heat Exchanger Test Bench <p>Technical data:</p> <p>Heat transfer surface of 200cm²</p> <p>Tube bundle, stainless steel with outer diameter of 6mm and wall thickness of at least 1mm</p> <p>Shell, transparent (PMMA) with outer diameter of 50mm and wall thickness of at least 3mm</p>
	<p>3. Test Stand for Single-Cylinder Engines, 3kW</p> <p>Specification :</p> <ul style="list-style-type: none"> - Test stand for mounting of prepared single-cylinder engines (two-stroke and four-stroke) with a maximum power output of 3kW - Engine started by Universal Drive and Brake Unit - The Universal Drive and Brake Unit acting as a brake generates the engine load - Force transmission from engine to load unit via V-belt drive - Continuous adjustment of speed and torque using Universal Drive and Brake Unit - Vibration-dampened switch cabinet for display and control - Measuring tube with scale and pressure sensor for manual and electronic fuel consumption measurement - Measurement and display of air consumption, ambient temperature and fuel temperature - Measured value displays for engine exhaust gas temperature - Stabilisation tank for intake air - 3 supply tanks for different fuels - Software for data acquisition via USB under Windows 7, 8.1, 10 <p>Technical data :</p> <p>3 fuel tanks: 5 liters each</p> <p>Measuring ranges :</p> <ul style="list-style-type: none"> - Temperature: <ul style="list-style-type: none"> -- 0 to 100°C (ambient) -- 0 to 100°C (fuel) -- 0 to 1000°C (exhaust gas) - Air consumption: 30 to 333L/min

	<p>Specification: quartz pressure transducer Technical data: Pressure transducer - measuring range: 0 to 100bar - maximum operating temperature: at least 200°C - maximum allowable pressure: at least 250bar" "Accessory 6: Electronic engine indicating system Cylinder pressure indication system Specification: - Cylinder pressure indication system for internal combustion engine - Only to be used in conjunction with pressure transducers for both gasoline and diesel engines - Chronological representation of pressure curve against the crank angle in p-t diagram to determine the maximum pressure and to monitor the ignition point and the pressure increase - Representation of pressure curve against the standardised piston capacity in p-V diagram to determine the indicated power output - System consists of measuring amplifier and software - Software for data acquisition via USB under Windows 7, 8.1, 10 Technical data: Measuring amplifier - amplification factor: 10mbar/mV - TDC sensor trigger distance : - 1mm Power Requirement : 230V, 60Hz, 1 phase" "Accessory 7: Exhaust gas analysing unit Measurement of exhaust gas relevant parameters on internal combustion engines Specification : - Exhaust gas analysis unit for engines - Menu-based display for calibration, operation and displaying measured values - Temperature sensor for measurement of engine oil temperature - USB interface Technical data : Working temperature: 5 to 45°C Measuring ranges - CO: 0 to 10% vol. - CO2: 0 to 20% vol. - O2: 0 to 22% vol. - HC: 0 to 2500ppm vol. - lambda: 0 to 9,999 oil temperature: 0 to 130°C - accuracy classes 1 and 0 Power requirement : 230V, 60Hz, 1 phase" Warranty: One (1) year against factory defects and Two (2) years after-sales service and support Must include on-site training to TSU Faculty</p>	<p>- Fuel consumption: 0 to 50cm³/min Power requirement: 230V, 60Hz, 1 phase Accessory 1: Universal Drive and Brake Unit Specification: - Drive and brake unit used for studying different driving or driven machines - Asynchronous motor with frequency converter allows 4-quadrant operation: generator or motor mode - Asynchronous motor with pendulum suspension, torque measurement via lever arm and force sensor - Optical sensor for recording the speed - Data exchange between base module and accessories through data cable - Measured values for speed and torque are digitally displayed on the device Technical data: Asynchronous motor with frequency converter - power: at least 2200W - maximum speed: approximately 3000 rpm - maximum torque: approximately 12Nm "V-belt operation - length of V-belt: 1157mm, 1180mm, 1250mm - type of V-belt: SPA - diameter of V-belt pulley: 125mm Resistive load: 72Ω, 2400W Measuring ranges - torque: ±15Nm - speed: 0 to 5000 rpm Power requirement: 230V, 60Hz, 3 phases" "Accessory 2: Four-stroke Gasoline Engine Air-cooled overhead valve four-stroke petrol engine Specification: - Air-cooled single-cylinder four-stroke petrol engine for installation in the Engine Test Stand - Engine mounted on vibration-insulated base plate - Force transmission to brake via pulley - Engine complete with fuel hose and exhaust gas temperature sensor - Fuel hose with self-sealing quick-release coupling Technical data : Air-cooled single-cylinder petrol engine - power output: approximately 2.2kW at 3200 rpm - bore: 62mm - stroke: 42mm Belt pulley: Ø 125mm" "Accessory 3: Pressure transducer and TDC sensor for Four Stroke Gasoline Engine Modified spark plug with piezoelectric pressure sensor Specification: - Modified spark plug carrying the actual pressure transducer - Quartz pressure transducer Technical data: Pressure transducer - measuring range: 0 to 100bar - maximum operating temperature: at least 200°C - maximum allowable pressure: at least 250bar" Accessory 4: Four-stroke diesel engine Air-cooled four-stroke diesel engine with direct injection</p>
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	<ul style="list-style-type: none"> - Force transmission from engine to load unit via V-belt drive - Continuous adjustment of speed and torque using Universal Drive and Brake Unit - Vibration-dampened switch cabinet for display and control - Measuring tube with scale and pressure sensor for manual and electronic fuel consumption measurement Measurement and display of air consumption, ambient temperature and fuel temperature - Measured value displays for engine exhaust gas temperature - Stabilisation tank for intake air - 3 supply tanks for different fuels - Software for data acquisition via USB under Windows 7, 8.1, 10 Technical data : 3 fuel tanks: 5 liters each Measuring ranges : '- Temperature: -- 0 to 100°C (ambient) -- 0 to 100°C (fuel) -- 0 to 1000°C (exhaust gas) - Air consumption: 30 to 333L/min - Fuel consumption: 0 to 50cm³/min Power requirement: 230V, 60Hz, 1 phase 	<p>'Specification:</p> <ul style="list-style-type: none"> - Air-cooled single-cylinder four-stroke diesel engine for for installation in the Engine Test Stand - Engine mounted on vibration-insulated base plate Force transmission to brake via pulley - Engine complete with fuel hose and exhaust gas temperature sensor - Fuel hose with self-sealing quick-release coupling Technical data : Air-cooled single-cylinder diesel engine - power output: approximately 3kW at 3000rpm - bore: 69mm - stroke: 62mm V-belt: Ø 125mm " "Accessory 5: Pressure transducer and TDC sensor for Four Stroke Diesel Engine Pressure measurement in the combustion chamber of an engine using a micro pressure transducer Specification: quartz pressure transducer Technical data: Pressure transducer - measuring range: 0 to 100bar - maximum operating temperature: at least 200°C - maximum allowable pressure: at least 250bar" "Accessory 6: Electronic engine indicating system Cylinder pressure indication system Specification: - Cylinder pressure indication system for internal combustion engine - Only to be used in conjunction with pressure transducers for both gasoline and diesel engines - Chronological representation of pressure curve against the crank angle in p-t diagram to determine the maximum pressure and to monitor the ignition point and the pressure increase - Representation of pressure curve against the standardised piston capacity in p-V diagram to determine the indicated power output - System consists of measuring amplifier and software - Software for data acquisition via USB under Windows 7, 8.1, 10 Technical data: Measuring amplifier - amplification factor: 10mbar/mV - TDC sensor trigger distance : - 1mm Power Requirement : 230V, 60Hz, 1 phase" "Accessory 7: Exhaust gas analysing unit Measurement of exhaust gas relevant parameters on internal combustion engines Specification : - Exhaust gas analysis unit for engines - Menu-based display for calibration, operation and displaying measured values - Temperature sensor for measurement of engine oil temperature - USB interface Technical data : Working temperature: 5 to 45°C Measuring ranges - CO: 0 to 10% vol. - CO₂: 0 to 20% vol.
6.	<p>Radial Compressor Test Rig</p> <p>Two-stage compressor: recording of the compressor curve for both stages</p> <p>Specification:</p> <ul style="list-style-type: none"> - Functioning and operating behaviour of a radial compressor - Two-stage radial compressor with drive motor - Variable speed via frequency converter - Transparent intake and delivery pipes - Throttle valve for adjusting the air flow in the delivery pipe - Protecting plate at air inlet for undisturbed air flow - Determination of flow rate via intake nozzle - Display of differential pressures, flow rate, speed, electrical power consumption and hydraulic power output, temperatures and efficiency - Display and evaluation of the measured values as well as operation of the unit via software - Software with control functions and data acquisition via USB under Windows 7, 8.1, 10" 	
7.	<p>Comparison of Positive Displacement Pumps and Compressors Test Rig</p> <p>Interchangeable driven machines: three pump types, two compressor types</p> <p>Specification:</p> <ul style="list-style-type: none"> - Comparison of driven machines for liquid and gaseous media - Closed water circuit - 2 compressors: piston compressor and rotary vane compressor - 4 pumps: piston pump, impeller pump, 2 centrifugal pumps - Drive motor with variable speed - Flow determined by level (water) or Venturi tube (air) - Digital displays for pressure, differential pressure, temperature, speed and drive 	

	power - Software for data acquisition via USB under Windows 7, 8.1, 10"		- O2: 0 to 22% vol. - HC: 0 to 2500ppm vol. - lambda: 0 to 9,999 oil temperature: 0 to 130°C - accuracy classes 1 and 0 Power requirement : 230V, 60Hz, 1 phase"
8.	Equipment for Fundamentals of Temperature Measurement Specification: - Experiments in the fundamentals of temperature measurement with 7 typical measuring devices - Various heat sources or storage units: laboratory heater, immersion heater, vacuum flask - Calibration units: precision resistors and digital multimeter - Liquid, bimetallic and gas pressure thermometers - Temperature sensors: Pt100, thermocouple type K, thermistor (NTC) - Various temperature measuring strips - Psychrometer for humidity measurement"		Warranty: One (1) year against factory defects and Two (2) years after-sales service and support Must include on-site training to TSU Faculty
10.	Radial Fan Test Rig Operating behavior and characteristic variables of a radial fan; two interchangeable rotors Specification: - Functioning and operating behavior of a radial fan - Radial fan with 3-phase AC motor - Variable speed via frequency converter - Transparent intake and delivery pipes - Throttle valve to adjust the air flow in the delivery pipe - Interchangeable rotors: 1 rotor with forward curved blades and 1 rotor with backward curved blades - Determination of flow rate via intake nozzle - Display of differential pressure, flow rate, speed, electrical power consumption and hydraulic power output, temperature and efficiency - Display and evaluation of the measured values as well as operation of the unit via software - Software with control functions and data acquisition via USB under Windows 7, 8.1, 10"	6.	Radial Compressor Test Rig Two-stage compressor: recording of the compressor curve for both stages List of experiments: - Operating behaviour and characteristic variables of a radial compressor - Recording of the compressor curve for both stages - Effect of the rotor speed on the pressure - Effect of the rotor speed on the flow rate - Distribution of stage pressure ratios - Effect of compression on the temperature increase - Determination of hydraulic power output and efficiencies Specifications: - Functioning and operating behaviour of a radial compressor - Two-stage radial compressor with drive motor - Variable speed via frequency converter - Transparent intake and delivery pipes - Throttle valve for adjusting the air flow in the delivery pipe - Protecting plate at air inlet for undisturbed air flow - Determination of flow rate via intake nozzle - Display of differential pressures, flow rate, speed, electrical power consumption and hydraulic power output, temperatures and efficiency - Display and evaluation of the measured values as well as operation of the unit via software - Software with control functions and data acquisition via USB under Windows 7, 8.1, 10 Technical data: Intake pipe: inner diameter of at least 44mm Delivery pipe: inner diameter of least 34mm Two-stage radial compressor: - power consumption of at least 1000W - speed: 1000 to 16000 rpm - maximum volumetric flow rate of at least 180m ³ /h - maximum pressure difference at least of 235mbar Measuring ranges: - differential pressure (stage 1 / stage 2): 0 to 350mbar - flow rate: 0 to 120m ³ /h - temperature: 2 x 0 to 100°C - speed (compressor): 0 to 21000 rpm - electrical power consumption: 0 to 1000W Power requirement: 230V, 60Hz, 1 phase
11.	Axial Fan Test Rig Operating behaviour and characteristic variables of an axial fan Specification - Functioning and operating behaviour of an axial fan - Axial fan with electronically commutated drive motor - Variable speed via integrated controller - Transparent intake and delivery pipes - Throttle valve to adjust the air flow in the delivery pipe - Determination of flow rate via intake nozzle - Display of differential pressure, flow rate, speed, electrical power consumption and hydraulic power output, temperature and efficiency - Due to integrated microprocessor-based instrumentation no additional devices with error-prone wiring are required	8.	Equipment for Fundamentals of Temperature Measurement


	<ul style="list-style-type: none"> - Display and evaluation of the measured values as well as operation of the unit via software - Software with control functions and data acquisition via USB under Windows 7, 8.1, 10 	<p>Experimental introduction to temperature measurement: methods, areas of application, characteristics</p> <p>List of experiments:</p> <ul style="list-style-type: none"> - Learning the fundamentals of temperature measurement by experimentation - Familiarization with the various methods, their areas of application and special features <ul style="list-style-type: none"> -- non-electrical methods: gas- and liquid-filled thermometers, bimetallic thermometers and temperature measuring strips -- electric methods: thermocouple, resistance temperature detector Pt100, thermistor (NTC) - determining air humidity with a psychrometer - calibrating electric temperature sensors <p>Specifications:</p> <ul style="list-style-type: none"> - Experiments in the fundamentals of temperature measurement with 7 typical measuring devices - Various heat sources or storage units: laboratory heater, immersion heater, vacuum flask - Calibration units: precision resistors and digital multimeter - Liquid, bimetallic and gas pressure thermometers - Temperature sensors: Pt100, thermocouple type K, thermistor (NTC) - Various temperature measuring strips - Psychrometer for humidity measurement - Tool case for sensors, cables, measuring strips and immersion heater <p>Technical data:</p> <p>Immersion heater</p> <ul style="list-style-type: none"> - power output: at least 300W - adjustment of power feed via power-regulated socket <p>Laboratory heater with thermostat</p> <ul style="list-style-type: none"> - power output: at least 450W - max. temperature: at least 425°C <p>Vacuum flask: 1 liter</p> <p>Measuring ranges</p> <ul style="list-style-type: none"> - resistance temperature detector Pt100: 0 to 100°C - thermocouple type K: 0 to 1000°C - thermistor (NTC): 20 to 55°C - liquid thermometer: -10 to 250°C - bimetallic, gas pressure thermometer: 0 to 200°C - temperature measuring strips: 29 to 290°C <p>Precision resistors: 10 Ω, 100 Ω, 1000 Ω</p> <p>Psychrometer</p> <ul style="list-style-type: none"> - 2x temperature: 0 to 60°C - rel. humidity: 3 to 96% <p>Power Requirement: 230V, 60Hz, 1 phase</p>
12.	<p>Steam Power Plant</p> <p>Technical Specifications</p> <p>Steam engine:</p> <ul style="list-style-type: none"> • Maximum power: 5W • Maximum speed: 1200 per minute • Cylinder diameter: 20 mm • Generator: DC motor: max. 3,18W at 6000min-1 <p>Gas-fired boiler</p> <ul style="list-style-type: none"> • safety valve: 4bar • gas connection 3/8"L (propane or butane) <p>Measuring ranges</p> <ul style="list-style-type: none"> • Temperature: 8 x -20 to 200°C • Pressure: 0 to 6 bars • Flow rate: <ul style="list-style-type: none"> · 0 to 110 L/h (gas) 15 to 105 L/h (water) • Voltage: 0 to 10 VDC • Current: 0 to 250mA <p>Delivery: 120 days</p> <p>Warranty: One Year against factory defects, Two years on after-sales service</p>	<p>10. Radial Fan Test Rig</p> <p>Operating behavior and characteristic variables of a radial fan; two interchangeable rotors</p> <p>List of experiments:</p> <ul style="list-style-type: none"> - Operating behaviour and characteristic variables of a radial fan - Recording the fan characteristic (pressure difference as a function of the flow rate) - Effect of the rotor speed on the pressure

	<ul style="list-style-type: none"> - Effect of the rotor speed on the flow rate - Effect of different blade shapes on the fan characteristic and efficiency - Determination of hydraulic power output and efficiencies <p>Specifications:</p> <ul style="list-style-type: none"> - Functioning and operating behavior of a radial fan - Radial fan with 3-phase AC motor - Variable speed via frequency converter - Transparent intake and delivery pipes - Throttle valve to adjust the air flow in the delivery pipe - Interchangeable rotors: 1 rotor with forward curved blades and 1 rotor with backward curved blades - Determination of flow rate via intake nozzle - Display of differential pressure, flow rate, speed, electrical power consumption and hydraulic power output, temperature and efficiency - Display and evaluation of the measured values as well as operation of the unit via software - Software with control functions and data acquisition via USB under Windows 7, 8.1, 10 <p>Technical data:</p> <ul style="list-style-type: none"> - Intake pipe: inner diameter at least 90mm, length at least 430mm <p>Delivery pipe:</p> <ul style="list-style-type: none"> - inner diameter: at least 100mm and length of approximately 530mm <p>Radial fan:</p> <ul style="list-style-type: none"> - power consumption: at least 100W - nominal speed: at least 2800 rpm - maximum volumetric flow rate: approximately 500m³/h - maximum pressure difference: at least 300Pa <p>Measuring ranges</p> <ul style="list-style-type: none"> - differential pressure: 0 to 1800Pa - flow rate: 0 to 1000m³/h - temperature: 0 to 100°C - speed: 0 to 3300min⁻¹ - electrical power consumption: 0 to approximately 250W <p>Power requirement: 230V, 60Hz, 1 phase</p>
11.	<p>Axial Fan Test Rig</p> <p>Operating behaviour and characteristic variables of an axial fan</p> <p>List of experiments:</p> <ul style="list-style-type: none"> - Operating behavior and characteristic variables of an axial fan - Recording the fan characteristic (differential pressure as a function of the flow rate) - Effect of the rotor speed on the pressure - Effect of the rotor speed on the flow rate - Stall - Determination of hydraulic power output and efficiencies <p>Specification</p> <ul style="list-style-type: none"> - Functioning and operating behaviour of an axial fan - Axial fan with electronically commutated drive motor

	<ul style="list-style-type: none"> - Variable speed via integrated controller - Transparent intake and delivery pipes - Throttle valve to adjust the air flow in the delivery pipe - Determination of flow rate via intake nozzle - Display of differential pressure, flow rate, speed, electrical power consumption and hydraulic power output, temperature and efficiency - Due to integrated microprocessor-based instrumentation no additional devices with error-prone wiring are required - Display and evaluation of the measured values as well as operation of the unit via software - Software with control functions and data acquisition via USB under Windows 7, 8.1, 10 <p>Technical data: Intake pipe: inner diameter at least 110mm and length of approximately 275mm Delivery pipe: inner diameter of at least 110mm and length of approximately 310mm Axial fan: - power consumption: at least 90W - nominal speed: 9500 rpm - maximum volumetric flow rate: approximately 600m³/h - maximum pressure difference: approximately 700Pa Measuring ranges: - differential pressure: 0 to 1800Pa - flow rate: 0 to 1000m³/h - temperature: 0 to 100°C - speed: 0 to 9999 rpm - power consumption: 0 to 500W Power requirement: 230V, 60Hz, 1 phase</p>
12.	<p>Steam Power Plant A full-size lab trainer that demonstrates a steam power plant with single-cylinder piston steam engine •Trainer must contain the following major components, but not limited to; mounted in a sturdy and ergonomic working station</p> <ol style="list-style-type: none"> 1. Steam engine 2. Steam Boiler 3. Feedwater Tank 4. Burner 5. Generator 6. Condenser <p>Must have heavy-duty castor wheels for easy mobility Trainer set must be inclusive of delivery, installation and training with corresponding laboratory experiment manual Power supply voltage: 230 V, single-phase Frequency: 60 Hz Nominal consumption (power): 0.13 kW Sound: 65 dB(A) Cold water supply flow rate: 100 L/h minimum Steam engine, double-acting Number of cylinders: 1 Bore: 20 mm Stroke: 20 mm Steam condition: 4 bar Max. steam consumption: 1 kg/h (saturated)</p>

	<p>Steam Max. speed: 1200 1/min Max. power: 5 W Lubricating oil: For steam pipe before steam cylinder: Hot steam oil For bearing points: Machine oil Boiler: Flue-flame tube boiler Gas heated Heating area approx. 970 cm² Operating pressure: <4 bar Safety valve: 4 bars Fuel: Propane Standard density n = 2,01 kg/m³ Thermal power Hu = 46354 kJ/kg Butane Standard density □n = 2,71 kg/m³ Thermal power Hu = 45715 kJ/kg Gas inlet pressure: (0.5 - 4bar) 800 mbar Max. flue gas temperature: 200 °C Min. flame monitor temperature: 600 °C Condenser: Atmospheric Transfer area: 63 cm² Cooling water consumption: 100 L/h Supply lines Cooling water connection: Rapid action coupling NW7.8 Hose 1/2 " Gas connection: 3/8 " Gas flow meter Measuring range: 110 L/h Max. pressure: 2.5 bar Cooling water flow meter measuring range: 15 to 105 L/h A full-size lab trainer that demonstrates a steam power plant with single-cylinder piston steam engine •Must be able to show and demonstrate how a steam engine works •Trainer must contain the following major components, but not limited to; mounted in a sturdy and ergonomic working station 1. Steam engine 2. Steam Boiler 3. Feedwater Tank 4. Burner 5. Generator 6. Condenser •Must have heavy-duty castor wheels for easy mobility •Trainer set must be inclusive of delivery, installation and training with corresponding laboratory experiment manual Delivery: 120 days Warranty: One Year against factory defects, Two years on after-sales service</p>
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For guidance and information of all concerned.


DR. GRACE N. ROSETE
Chairperson – Goods and Services
