TENDER DOCUMENTS

MECHANICAL LAB EQUIPMENT

NUTECH/SCM/Mechanical Lab-2019/TD-034

NATIONAL UNIVERSITY OF TECHNOLOGY

TENDER NOTICE

National University of Technology (NUTECH)

NUTECH/SCM/Mechanical Lab-2019/TD-034

Sealed bids are invited from Government / FBR Registered Firms for the procurement of Mechanical laboratory equipment for NUTECH Technology Labs.

1. Tender documents containing terms & conditions and detailed specifications of items can be downloaded from NUTECH website "https://nutech.edu.pk/d-p.php" w.e.f **12 Feb 2019.**
2. Quotations shall be submitted as per requirement of the tender documents.
a. Bidders will be required to submit bank draft/PO equal to 5% of quoted value as Bid Bond in favor of National University of Technology (NUTECH).
3. Sealed bids with detailed specification should reach on the following address latest by **1030 hours on 04 Mar 2019.** Late submission will not be entertained.
4. Bids will be opened at **1100 hours** on **04 Mar 2019** at SCM Office.
5. Project is to be completed in 75 days from the date of award of contract.
6. Submit Rs 1500/- as Tender fee in favour of NUTECH, **Bank Alfalah Acct:5546-5001002354.** Please attach bank receipt with technical offer. Offers will not be entertained without payment of processing fee.

Deputy Director (Supply Chain Management Office)
NATIONAL UNIVERSITY OF TECHNOLOGY (NUTECH) IJP ROAD, SEC I-12, ISLAMABAD
Tel: 0092-51-5476768, Ext :178

NATIONAL UNVERSITY OF TECHNOLOGY

SUPPLY CHAIN MANAGEMENT OFFICE

INVITATION TO TENDER

Submission Date/Time 04 Mar 2019 at 1030 hours

1. NUTECH desires to procure the list of item(s)/Store(s) as per **Annexure-A**. Interested bidders are requested to send their bids through courier or deliver at NUTECH under two separate sealed envelopes (placed together in third envelope), marked clearly, **"Technical Offer"** and **"Commercial Offer"**, respectively to the undersigned, latest by or before above mentioned due date. If due to any unforeseen circumstances, NUTECH establishment remains closed, then the last date of submission will be extended to next working day.

2. Please also note that Technical Offer should contain Annexes-A & B duly filled in (supported with relevant technical literature /details/ catalogues etc) and receipt of tender processing fee. Commercial Offer will contain Annexure- C and bid bond. Please ensure no space is left blank in the annexes.

3. Following must be noted for this IT (Invitation to Tender):-

a. 2 x copies of technical offer are to be provided.

b. Annexes A, B and C must be signed and stamped, Attach only relevant documents.

c. Please complete all document as per given format. Do not use any other format or letter head. Offer may be rejected if given format is not followed.

d. Validity of offer will be 90 days.

e. Delivery period will be 75 days from the date of award of contract..

f. Tender(s) must be accompanied with a Bid Bond in agreement of faithful compliance of the conditions of Contract/Purchase Order. This amount will be equivalent to 5% of the total quoted value. In case of non-acceptance of any offer, the Bid Bond will be returned to the bidder by fastest possible means. The Bid Bond amount submitted by the successful bidder will however, be refunded on effective termination of Contract/ Purchase Order. (The Bid Bond will be forfeited in case of default by the bidder from his commitments made through his offer). Submission of Bid Bond is mandatory, otherwise your offer will be rejected.

g. 2 years warranty against 5% bank guarantee will be required from the successful bidders from the date of commissioning.

h. Rates should be quoted on Free Delivery basis at NUTECH Islamabad.

4. We reserve the rights to accept or reject any or all tenders as a whole or in part without assigning any reason whatsoever. The decision in this regard will be firm, final and binding on all bidders.

DD (Supply Chain Management)

NATIONAL UNIVERSITY OF TECHNOLOGY

SUPPLY CHAIN MANAGEMENT OFFICE

TECHNICAL OFFER

Annex A

User Reference No **Mechanical Lab Eqpt-002**___ Date: **21-01-2019**

Technical Specification

Ser	Part No	Nomen/ Experiment	Description	Country of Origin	A/U	Qty Req	Bidder Compliance			Tech Scrutiny to be done by user	
							Yes	No	Alternate Offer	Accepted	Rejected
										Reason of Rejection	
1.		**Vibrations Trainer with DAQ**	Vibration trainer with experiments on damping, resonance, dual-mass system and vibration absorption 6 pendulum oscillators 2 bar-type oscillators 1 spring-mass oscillator Electrical imbalance exciter control unit for the imbalance exciter with a digital frequency display and a TTL output for triggering external devices Tune able absorber with a leaf spring adjustable oil damper Electrically operated drum recorder for recording free vibrations Polar chart recorder for determining the amplitude and phase of forced	North America, Europe, Japan South Korea	Nos	1					

			vibrations Technical data Beam, rigid: LxWxH: 700x25x12mm, 1.6kg Beam, elastic: LxWxH: 700x25x4mm, 0.6kg Tension-pressure springs 0.75N/mm, 1.5N/mm, 3.0N/mm, Imbalance exciter 0 to 50Hz, 100cmg Oil damper: 5 to 15Ns/m Absorber leaf spring: - WxH: 20x1.5mm total mass: approx. 1.1kg Tune able: 5 to 50Hz Drum recorder: - 20mm/s, width 100mm Polar chart recorder: - Ø 100mm **Experimental Capabilities: -** Experiments with a. Pendulums b. Spring-mass system c. Bar-type oscillator d. Undamped oscillation e. Damped oscillation f. Forced vibration g. Damped and un damped resonance h. Absorber effect in multi-mass oscillators.							
2.		**Moment of Inertia with DAQ**	Rotating bar Length: 550mm Masses: 2x 0.1kg, 2x 0.2kg, 2x 0.4kg Solid cylinder Diameter: 120mm, Mass: 0.9kg Hollow cylinder Outer diameter: 120mm, Inner	North America, Europe, Japan South Korea	Nos	1				

			diameter: 110mm Mass: 0.9kg Weight for the drive 1N **Experimental Capabilities: -** a. Investigation of the inertia of various bodies in rotational motion hollow cylinder, solid cylinder or rotating bar with masses as a rotating body.							
3.		**Temperature Measuring Apparatus with DAQ**	Measuring ranges Resistance temperature detector Pt100: 0 to 200°C Thermocouple type K: 0 to 1200°C Thermistor (NTC): 20 to 55°C Liquid thermometer: -10 to 250°C Bimetallic thermometer Gas pressure thermometer: 0 to 200°C Temperature measuring strips: 29 to 290°C Precision resistors: 10 Ω, 100 Ω, 1000 Ω Psychrometer. 2x temperature: - 0 to 100°C Rel. humidity: - 3 to 96% Flow rate: 50…2500L/h Flow rate measurement with rotameter. water connections made using quick-release couplings **Experimental Capabilities: -** a. Function, type of construction and applications of bimetallic dial thermometers b. Function, type of construction and applications of liquid expansion thermometers, resistance thermometers and	North America, Europe, Japan South Korea	Nos	1				

			thermocouples c. Measuring precision, sensitivity and measuring errors of the different thermometers. d. Installation methods, installation errors and response e. Familiarization with the function of the individual temperature measuring instruments.							
4.		**Steam Power Plant with DAQ**	Material: - Stainless steel or better. Steam boiler with safety procedures installed Steam output: 200kg/h at 11 bar Max. fuel consumption: 12L/h Heat-up time: 8min Max. pressure: 13bar Super heater power 7kW Axial turbine with speed regulation mechanism. Power: 1.5kW at 3000min-1 Water-cooled condenser. Cooling capacity: 80-100 kW Transfer surface: 2.5m^2 Feed Water treatment installed. Speed Control system of the turbine. Vacuum system installed at the outlet of the turbine to assist in the pressure drop in the turbine. Introduction of load variation introduction at alternator. Grid synchronization working mode, all the electrical parameters supplied by the generator to the grid are measured. Computer controlled. Data acquisition system. **Experimental Capabilities: -**	North America, Europe, Japan South Korea	Nos	1				

			a. Steam power plant and its components b. Start-up, operation and shut down of a steam power plant c. Closed steam-water circuit with feed water treatment d. Calibration of sensors e. Determining the: - ➢ Boiler efficiency ➢ Mechanical/thermal efficiency of the turbine ➢ Condenser efficiency ➢ Specific fuel consumption of the plant								
5.		**Gas Turbine Jet Engine with DAQ**	Fuel: - kerosene JET-A1, Kerosene and Paraffin. Axial flow Compressor/turbine Thrust Minimum 150 KN. Sound level at 1 m distance: 130 db or less. Temperature sensors to measure: - Inlet air temperature. Inlet air temperature in the compressor. Fuselage temperature. Combustion chamber temperature. Exhaust gases temperature. Speed sensor to measure the speed (rpm) of the shaft of the turbine Force sensor to measure the thrust of the turbine, range: 0 – 300 N minimum. Pressure sensors to measure: - Static/Stagnation Pressure in the intake gases. Static/Stagnation Pressure at each stage of the compressor. Pressure in the combustion	North America, Europe, Japan South Korea	Nos	1					

			chamber. Static/Stagnation Pressure at each stage of the turbine. Flow sensors to measure: - Inlet air flow. Exhaust gases flow (Pitot with two pressure sensors). Fuel flow. Computer controlled. Data acquisition system. Experimental Capabilities: - a. Study of a gas turbine. b. Function and operation of a gas turbine as jet engine. c. Determination of fuel consumption. d. Determination of air and fuel ratio. e. Recording the relevant parameters of the turbine. f. Determination of the efficiency of the compressor. g. Determination of the turbine thrust. h. Determination of the efficiency of the gas turbine. i. Determination of the gas turbine characteristic curves. j. Determination of the compression ratio of the compressor at k. Different thrust regimes. l. Determination of the gas turbine specific consumption. m. Study of the safety systems in the operation of a gas turbine.							
6.		**Refrigeration Cycle with DAQ**	Open compressor Refrigeration capacity: Min 950W	North Americ		1				

			Heater: 1x 1000W Condenser, capacity: Min 1200W Refrigerant R513A, GWP: 631 CO_2-equivalent: 1.3t Measuring ranges Temperature: 9x -30 to 100°C, 1x 0 to 100°C Pressure: 1x -1 to 9bar, 1x -1 to 24bar, 4x -1 to 15bar Torque: (compressor) 0 to 10Nm Speed: (compressor) 0 to 2500min-1 Power consumption: (compressor) 0 to 1125W Power: (heater) 0 to 1125W Flow rate: (water) 5 to 70g/s Flow rate: (refrigerant) 0 to 0.5L/min Computer controlled and Data acquisition system. **Experimental Capabilities: -** a. Cyclic process in the log p-h diagram b. Comparison of the real cyclic process and the ideal cyclic process c. Balances at the evaporator and condenser d. Calculation of the motor power via speed and torque e. Determination of losses f. Calculation of the coefficient of performance g. Operating behavior under load h. Non-steady-state operating behavior.	a, Europe, Japan South Korea	Nos					
7.		**Heat Transfer Control Unit with DAQ**	This unit provides AC power for all of the modules. It also provides instrumentation and	North America,	Nos	2				

			control capability for all the modules. Calibration capabilities Computer controlled Data Acquisition System.	Europe , Japan South Korea						
	7a.	**Linear Heat Conduction Module with DAQ**	Diagram in the front panel illustrating the process. Brass specimens with different diameters. Stainless steel 25 mm of diameter High precision temperature sensors. Electric Heater. High Precision temperature sensors distributed in the module for measurement. Computer controlled. Data acquisition system. Cables and Accessories. Compatible with the main control unit. **Experimental Capabilities: -** a. To study the linear heat conduction of various solid conductors and insulators. b. To demonstrate the thermal conductivity of using different materials with different diameters.	North Americ a, Europe , Japan South Korea	No s	1				
	7b.	**Radial Heat Conduction Module with DAQ**	Diagram in the front panel illustrating the process. Brass disk of 110 mm of diameter and 3 mm of thickness. Electric heater. High Precision temperature sensors distributed in the module for measurement. Control through computer and PLC. Data acquisition system.	North Americ a, Europe , Japan South Korea	No s	1				

			Cables and Accessories. Compatible with the main control unit. **Experimental Capabilities: -** a. Determination of the temperature profile b. Determination of the thermal conductivity λ							
	7c.	**Free and Forced Convection Module with DAQ**	Diagram in the front panel illustrating the process. Different heat exchange geometries Flat plate, Cylinder, Tube bundle Heating element for each exchanger. Variable speed Axial fan. High precision temperature sensors. Cables and Accessories. Computer controlled. Data acquisition system. Compatible with the main control unit. **Experimental Capabilities: -** a. Free and forced convection b. Calculation of convective heat transfer at different geometries. c. Experimental determination of the Nusselt number. d. Investigation of the relationship between flow formation and heat transfer during experiments. e. Description of transient heating process.	North America, Europe, Japan South Korea		1				
	7d.	**Extended Surface Heat Transfer Module with DAQ**	Diagram in the front panel illustrating the process. Interchangeable fins, with different materials like brass and stainless	North America, Europe	Nos	1				

			steel. Different cross section shapes: square, circular and hexagonal. High precision temperature sensors. Cables and Accessories. Computer controlled. Data acquisition system. Compatible with the main control unit. **Experimental Capabilities: -** a. To demonstrate the temperature profiles and heat transfer characteristics for extended surface. b. To demonstrate the cooling rate of different materials like brass and stainless steel and cross sectional shapes c. To demonstrate the heat transfer coefficient of different cross sections like square, circular and hexagonal.	, Japan South Korea						
	7e.	**Unsteady State Heat Transfer Module with DAQ**	Diagram in the front panel illustrating the process. Shapes of different materials and diameters. Brass sphere and cylinder with different diameters. Stainless steel sphere and cylinder with different diameters. Aluminum rectangular slab. Stainless steel rectangular slab. High precision temperature sensors. Cables and Accessories. Should be compatible with the main heat transfer control unit. Computer controlled Data acquisition system.	North America, Europe, Japan South Korea	Nos	1				

			Experimental Capabilities: - a. Study of the transient heat conduction and convection. b. Study of different temperature/time profiles for different shapes and materials.							
	7f.	**Radiation Heat Transfer Module with DAQ**	Heating element (ceramic). Lamp 150 W with diffuser. Light accessories: Luxmeter Scale: Resolution: Accuracy: 0 to 1999 lux 1 lux 2000 to 19990 10 lux 20000 to 50000 100 lux 8% Selection of light Day, Tungsten, fluorescence or mercury Sensor Photodiode with filter of adjustment of filter Sample frequency: 0.4 s Work temperature: 0 to 50ºC Filters: 3 Grey Neutral Density A153 filters. 1 Grey Neutral Density A152 filter. 1 Grey Neutral Density A154 filter. 3 Filter portholes. Radiometer Elements for studying the radiation and each one contains one temperature sensor Polished aluminum. Anodized aluminum. Brass. 2 Black bodies. Variable slit or aperture to regulate the area of the radiation. High precision temperature sensors. Heating Element. Power measurement (Wattmeter) Radiation measurement.	North America, Europe, Japan South Korea	Nos	1				

			Lux measurement from the luxmeter. Cables and Accessories Computer controlled. Data acquisition system. Compatible with the main control unit. **Experimental Capabilities: -** a. Measurement of the temperature, radiation, intensity light and the power in the heating element or bulb. b. Verify Lambert's inverse-square law c. Verify Stefan-Boltzmann law d. Verify Kirchhoff's law e. Study transient behavior f. Create power balances g. Produce logarithmic diagrams for evaluations								
8.		**Transducers, Instrumentation & Control Teaching Set with DAQ**	Input Transducers: Carbon track. Wire wound & precision rotary potentiometers. Slide potentiometers. NTC thermistors. Type 'K' thermocouples. I.C. temperature sensor. Photoconductive cell. Photovoltaic cell. Phototransistor. PIN diode. Linear variable differential transformer. Linear variable capacitor. Strain gauge. Air-flow sensor. Air pressure sensor. Slotted opto-sensor. Reflective opto-sensor. Inductive Proximity Sensor. Hall Effect sensor. Precision servo-potentiometer. Tacho-generator. Humidity sensor. Dynamic	North America, Europe, Japan South Korea	Nos	1					

			microphone. Ultrasonic receiver. Output Devices: Heater. Filament Lamp. DC Motor. Solenoid Air Valve. Ultrasonic transmitter. Buzzer. Loudspeaker. Relay. Solenoid. Counter/timer unit with LED display. Bar graph voltage indicator. Analog 10V center-zero meter. Signal Conditioning Circuits: Buffers. Inverters. Comparator with switchable hysteresis. Amplifiers with gain and offset control. Current amplifier. Summing amplifier. Differential amplifier. Instrumentation amplifiers. AC amplifier. Oscillator 40kHz. Filter 40kHz. Low-pass filter with switchable time constant. Precision full-wave rectifier. Sample and hold circuit. Integrator with switchable time constant. Differentiator with switchable time constant. V/F and F/V converters. V/I and I/V converters. Alarm oscillator with switchable latching. Power amplifier. Electronic switch. Internal Power Supplies: -5V, +5V 1A precision supply. -12V, +12V 1A regulated supply. Pneumatic Supply: Internal Pneumatic pump. D.C. motor, tacho-generator, slotted and reflective opto-sensors for incremental and absolute position, and a 360 degree precision potentiometer with indicator dial for closed-loop position control experiments. System Includes: Trainer. Accessory and Lead Kit.							

			Mains Lead. Curriculum Manual. Student Manual. Instructors Manual. Technical Manual. All Manuals in PDF Format on CDROM. Function Generator. Auto-ranging Digital Millimeter (Qty: 2). Digital Storage Oscilloscope.								
9.		**PLCs Trainer Teaching Set**	To perform a comprehensive range of programming tasks using a programmable logic controller (PLC). Capable of PLC programming in four different IEC 61131 languages a) Ladder Logic b) Sequential Function Chart c) Function Block d) Structured Text with Electro Mechanical Training e) System demonstrating the positioning and motion processes.	North America, Europe, Japan South Korea	Nos	1					
10.		**Process Control and Instrumentation Apparatus with DAQ**	Material: - Stainless Steel / Acrylic / Metacrylate. All Components should be clearly visible Option to Control through separate PLC / DCS Data Acquisition System. A variable PID/ Controller to see effects of each parameter on the control system 4-20mA, HART, Foundation Fieldbus, Profibus. Must Include the following modules. (a) Level Measurement (b) Flow Measurement (c) Temperature Measurement (d) Pressure Measurement	North America, Europe, Japan South Korea	Nos	1					

			Equipment should be supplied as a set of all modules integrated together in the form of a single working unit if possible. **Experimental Capabilities of all Modules: -** a. Understanding of the ➢ the level, flow, temperature and pressure sensors/transmitters working principles. ➢ the level, flow, temperature, Pressure Process Plant isometric drawings. ➢ the Instrumentation diagram and wiring of all process plants. b. Operation, calibration and maintenance of level, flow, temperature and pressure sensors and instruments. c. Install instruments according to the instrument mounting drawing. d. Wire transmitter to the controller. e. Configure the controller.							
11.		**Methods to determine the elastic line Mohrs Analogy with DAQ**	Beam Length: 1000mm cross-section: 20x4mm material: steel Weights 7x 1N (hanger), 28x 1N, 21x 5N Measuring ranges force: ±50N, graduation: 1N, travel: 0 to 20mm, graduation: 0.01mm **Experimental Capabilities: -** a. Elastic lines for statically	North America, Europe, Japan South Korea	Nos	1				

			determinate or indeterminate beams under load b. Determination of the elastic line of a beam by the principle of virtual work (calculation) c. Mohr's analogy (area moment method devised by Mohr; graphical representation) d. Application of the principle of superposition e. Determination of the maximum deflection of the beam f. Angle of inclination of the beam g. Comparison between calculated and measured values for angle of inclination and deflection							
12.		**Buckling behavior of Bars with DAQ**	Test bars Quantity: 11 Bar lengths: 350 to 700mm or more Materials: aluminum, copper, brass, steel, GFRP Cross-sections: 10x4mm, 25x6mm, 25x10mm Load spindle Force: max. 2000N Stroke: max. 10mm Lateral deflection: max. 20mm Sample holder hole diameter: Ø 20mm Weight for lateral load: max. 20N 1x 5N (hanger), 3x 5N Measuring ranges Force: 0 to 2500N, graduation: 50N	North America, Europe, Japan South Korea	Nos	1				

			deflection: 0 to 20mm, graduation: 0.01mm **Experimental Capabilities: -** a. Investigation of buckling behavior under the influence of ➢ different supports and clamps. ➢ different bar lengths and cross-sections ➢ different materials. b. Testing Euler's theory, buckling on elastic bars. c. Calculation of the expected buckling force with Euler's formula d. Measurement of force and deflection							
13.		**Deformation of Straight Beams with DAQ**	3 steel beams with different cross-sections 1 brass and 1 aluminum beam 3 articulated, height-adjustable supports with force gauge 1 support with clamp fixing force gauges can be zeroed 3 dial gauges to record deformations weights with adjustable hooks anodized aluminum section frame housing the experiment storage system to house the components Beam length: 1000mm Cross-sections: 3x20mm (steel), 4x20mm (steel), 6x20mm (Steel, Brass, Aluminum) Frame opening: 1320x480mm Weights 4x 2.5N (hanger), 4x 2.5N,	North America, Europe, Japan South Korea	Nos	1				

			16x 5N Measuring ranges Force: ±50N, graduation: 1N Travel: 0 to 20mm, graduation: 0.01mm **Experimental Capabilities: -** a. Investigation of the deflection for statically determinate and statically indeterminate Straight beams Cantilever beam, Single-span beam, dual- or triple-span beam b. Formulation of the differential equation for the elastic line c. Deflection on a cantilever beam d. Measurement of deflection at the force application point e. Deflection of a dual-span beam on three supports f. Measurement of the support reactions g. Measurement of the deformations h. Influence of the material (modulus of elasticity) and the beam cross-section (geometry) on the elastic line i. Application of the principle of virtual work on statically determinate and indeterminate beams j. Determination of lines of influence Arithmetically								
14.		**Combined Bending and Torsion**	3 beams: I, L and U profiles Clamping flange with angle scale to indicate the angular position of the	North America,	Nos	1					

		Loading with DAQ	beam Eccentricity of load application point adjustable. 2 dial gauges with bracket to record the horizontal and vertical deformation of the beam under load Storage system to house the components Aluminum beam Deformed length: 500mm Eccentricity of load application point: 0 to 25mm Dial gauges 0 to 10mm, Graduation: 0.01mm Angle scale 0 to 360°, Graduation: 1° Weights 1x 2.5N (hanger), 1x 2.5N , 3x 5N **Experimental Capabilities: -** a. Product moment of inertia and axial second moment of area. b. Bernoulli hypothesis. c. Symmetrical bending on a beam (uniaxial) ➢ with I-profile ➢ with L-profile ➢ with U-profile d. Unsymmetrical bending (complex) on a beam. e. Combined bending and torsion loading by way of eccentric force application. f. Determination of the shear center on a beam with a U-profile. g. Familiarization with shear	Europe , Japan South Korea							

			flow (shear forces in a cross-section) h. Comparison of calculated and measured values							
15.		**Gauge factor measurement Apparatus of Strain Gauge with DAQ**	Bending bar with 2 strain gauges on the compression side and tension side respectively. Strain gauge configured as full bridge 2-point ball bearing mounting of bar permits purely bending load application Mechanical load application device. Dial gauge with adjustable dial for direct measurement of deflection Measuring amplifier with 4-digit digital display. Bending bar made of steel: 660x25x12mm Strain gauge application full bridge, 350 Ohm Two strain gauges on the top and underside of the bar respectively. Amplifier measuring range: ±2mV/V Resolution: 1µV/V Zero balancing adjustment range: ±1mV Dial gauge 0 to 20mm Graduation: 0.01mm **Experimental Capabilities: -** a. Fundamentals of measurement using strain gauges. b. Determination of the gauge factor of strain gauges.	North America, Europe, Japan South Korea	Nos	1				

16.		**Stress and Strain analysis on a thin walled cylinder with DAQ**	Aluminum vessel Length: 400mm Diameter: Ø=75mm Wall thickness: - 2.8mm Internal pressure: - max. 3.5N/mm^2 (35bar) 5 strain gauges: half-bridges, 350 Ohm Angular position to the vessel axis: 0°, 30°, 45°, 60°, 90° Gauge factor: 2.00 ±1% Manometer 0 to 40bar accuracy: class 1.0 **Experimental Capabilities: -** a. Determination of the principal stresses: axial and circumferential stresses by magnitude and direction. ➢ in an open vessel (pipe) ➢ in a closed vessel (boiler) b. Comparison of open/closed vessels c. Determine Poisson's ratio d. Investigation of relations between strains, pressure and stresses in a plane biaxial stress state.	North America, Europe, Japan South Korea	Nos	1				

17.		**Torsion Testing Machine with DAQ**	Torque: - 10-500Nm. Grips: - 3 or 4 jaws chucks, key type chuck, keyless type chucks, collet grips, T-slot round platen, custom grips and fixtures Rotations: - 1000 times or 360'000° clockwise and counter-clockwise. Control: - Angle or torque closed loop control. Torque Accuracy: - In accordance with ISO 7500-1 and EN 10002-2, Grade 0.5. Torsion load Cell Data acquisition system. Computer Controlled. Test Specimens of different cross sections, diameters and materials. **Experimental Capabilities: -** a. Shear modulus of elasticity and second polar moment of area. b. Angle of twist dependent on clamping length. c. Angle of twist dependent on torque d. Influence of rigidity on torsion. e. Calculation of angle of twist. f. Comparison of calculated and measured angle of twist.	North America, Europe, Japan South Korea	Nos	1				

Special Instructions

Description	Bidder			Tech Scrutiny to be done by User		
	Yes	No	Alternate Offer	Accepted	Rejected	Reasons of Rejection
Environment Conditions: (a) Temperature range: 05ºC to +45ºC (b) Relative humidity: 0-70% non-condensing						
Warranty period: Two years from the date of commissioning.						
Training Notes: Supplier will provide a set of handouts for training on operation and maintenance of the equipment						
Publications Supplier is to provide hard and soft copies (CD) of following manuals. (a) **Operational / Maintenance manual**: - Qty 01 with Equipment and additional Qty 02 for record purposes and should consist of following sections:- (1)**Equipment Description /Operation**:- (a)Specifications (b)Description (c)Operation (2)**Servicing**:- (a)Maintenance Schedule (b)Adjustment / test (c)Removal / Installation procedure (d)Tools Used (3) Trouble shooting guide (4) Cleaning requirements (5) Shipping and receiving (6) Storage requirements (b) **IPB** (Illustrated Parts Breakdown Manual) should have full parts description along with detailed diagrams (exploded view). (c) **Experimental manuals** which must contain the list and procedure of the experiments that equipment can perform.						

Spares / Technical Support: (a) Supplier to have in-country spares / technical support and ensure spares and technical support / assistance for next 10 years (b) Comprehensive list of spares required for scheduled maintenance of Equipment is to be provided (c) Any software provided must have its license (d) Software upgrade support must be provided free of cost for 10 x years with renewed license at every upgrade (e) Supplier must also provide calibration service for at least 5 x years after commissioning						
Additional Spare / Replaceable parts: (a) Replaceable spare / parts during scheduled inspections are to be identified and provided as per requirement along with equipment sufficient to cater five years consumption. (b) All specialized / standard tools required for inspection / repair / servicing must be supplied along with equipment.						
Physical Inspection Criteria: 100% physical inspection of store will be carried out before commissioning of the equipment for following details:- (a) For physical damage, scratches and deformity. (b) Accessories /components as per contractual specifications. (c) Technical Manuals (Operation manual, user guide, IPBs). (d) Quality certificate and calibration certificate by the OEM (e) OEM certificate and verifiable documents by the supplier that store has been procured from certified source and is factory new and from latest production. (f) Brand name and country of origin.						
Commissioning: (a) Commissioning by OEM rep at his own cost and risk at designated place at NUTECH. (b) Any special requirement for installation, operation and commissioning must be specified in the offer by the supplier.						
Training: 01 week OEM operational/ maintenance training at						

NUTECH						
Improvement and Safety Measures: Any improvement and safety measures suggested by NUTECH during commissioning are to be resolved by the supplier / manufacturer at no extra cost.						
Liability of Supplier: (a) OEM certificate of authorized dealership Supplier is to provide original OEM certificate of subject equipment bought directly from the manufacturer and being an authorized dealer. (b) In case the equipment supplied is not compatible with specifications, the supplier will be obliged to call his representatives at his own cost for consultation and corrective action						
Special Notes: (a) Additional requirements for the maintenance of equipment (if any) must be intimated by the supplier in technical offer. (b) Supplier must provide the list of organizations using same equipment in Pakistan (if any). (c) Equipment must be a standard product of OEM available at web address of OEM. (d) In case of premature failure of the equipment, OEM has to replace / rectify the item free of cost. Required transportation charges would be borne by the supplier.						

Firm Name________
Signature__________
Name_____________
Designation___________

NATIONAL UNIVERSITY OF TECHNOLOGY
SUPPLY CHAIN MANAGEMENT OFFICE

TECHNICAL OFFER

Annex B

User Reference No **Mechanical Lab Eqpt-002**__ Date: **21-01-2019**

Please fill in the following essential parameters:

1. Validity of Offer:_______________________ Days (Should not be less than 90 days)
2. Delivery Period:_______________________ Days (After Placement of order)
3. Country of Origin:_______________________
4. Warranty/Guarantee: _____________ Months from the date of final acceptance of the stores.

General

GST No: _________________________ (Please enclose copy)

NTN/CNIC: ______________________________ (if exempted, please provide valid exemption certificate)

Payment Terms:

1. 50 % advance payment (Against valid bank Guarantee)
2. 50% Payment after delivery, installation /commissioning, user satisfaction certificate

Details of Payment Recipient

(1) Name/Title: ____

(2) Address:____

Signature: _____________________

Official Seal: ___________________

Name: ________________________

Designation: ___________________

NATIONAL UNIVERSITY OF TECHNOLOGY
SUPPLY CHAIN MANAGEMENT OFFICE

FINANCIAL OFFER

Annex C

User Reference No **Mechanical Lab Eqpt-002__** Date: **21-01-2019**

Ser	Part No	Nomen/ Experiment	Description	A/U	Qty Req	Unit Price (Rs) (excluding GST)	GST (If applicable)	Custom Duty (Rs) (If applicable)	Total amount (Rs)
1.		**Vibrations Trainer with DAQ**	Vibration trainer with experiments on damping, resonance, dual-mass system and vibration absorption 6 pendulum oscillators 2 bar-type oscillators 1 spring-mass oscillator Electrical imbalance exciter control unit for the imbalance exciter with a digital frequency display and a TTL output for triggering external devices Tune able absorber with a leaf spring adjustable oil damper Electrically operated drum recorder for recording free vibrations Polar chart recorder for determining the amplitude and	Nos	1				

			phase of forced vibrations Technical data Beam, rigid: LxWxH: 700x25x12mm, 1.6kg Beam, elastic: LxWxH: 700x25x4mm, 0.6kg Tension-pressure springs 0.75N/mm, 1.5N/mm, 3.0N/mm, Imbalance exciter 0 to 50Hz, 100cmg Oil damper: 5 to 15Ns/m Absorber leaf spring: - WxH: 20x1.5mm total mass: approx. 1.1kg Tune able: 5 to 50Hz Drum recorder: - 20mm/s, width 100mm Polar chart recorder: - Ø 100mm **Experimental Capabilities: -** Experiments with a) Pendulums b) Spring-mass system c) Bar-type oscillator d) Undamped oscillation e) Damped oscillation f) Forced vibration g) Damped and un damped resonance **h)** Absorber effect in multi-mass oscillators.						
2.		**Moment of Inertia with DAQ**	Rotating bar Length: 550mm Masses: 2x 0.1kg, 2x 0.2kg, 2x 0.4kg Solid cylinder Diameter: 120mm, Mass: 0.9kg Hollow cylinder	Nos	1				

			Outer diameter: 120mm, Inner diameter: 110mm Mass: 0.9kg Weight for the drive 1N **Experimental Capabilities: -** Investigation of the inertia of various bodies in rotational motion hollow cylinder, solid cylinder or rotating bar with masses as a rotating body.						
3.		**Temperature Measuring Apparatus with DAQ**	Measuring ranges Resistance temperature detector Pt100: 0 to 200°C Thermocouple type K: 0 to 1200°C Thermistor (NTC): 20 to 55°C Liquid thermometer: -10 to 250°C Bimetallic thermometer Gas pressure thermometer: 0 to 200°C Temperature measuring strips: 29 to 290°C Precision resistors: 10 Ω, 100 Ω, 1000 Ω Psychrometer. 2x temperature: - 0 to 100°C Rel. humidity: - 3 to 96% Flow rate: 50…2500L/h Flow rate measurement with rotameter. water connections made using quick-release couplings **Experimental Capabilities: -** a. Function, type of construction and applications of bimetallic dial thermometers	Nos	1				

			b. Function, type of construction and applications of liquid expansion thermometers, resistance thermometers and thermocouples c. Measuring precision, sensitivity and measuring errors of the different thermometers. d. Installation methods, installation errors and response e. Familiarization with the function of the individual temperature measuring instruments.						
4.		**Steam Power Plant with DAQ**	Material: - Stainless steel or better. Steam boiler with safety procedures installed Steam output: 200kg/h at 11 bar Max. fuel consumption: 12L/h Heat-up time: 8min Max. pressure: 13bar Super heater power 7kW Axial turbine with speed regulation mechanism. Power: 1.5kW at 3000min-1 Water-cooled condenser. Cooling capacity: 80-100 kW Transfer surface: 2.5m^2 Feed Water treatment installed. Speed Control system of the turbine. Vacuum system installed at the outlet of the turbine to assist in	Nos	1				

			the pressure drop in the turbine. Introduction of load variation introduction at alternator. Grid synchronization working mode, all the electrical parameters supplied by the generator to the grid are measured. Computer controlled. Data acquisition system. **Experimental Capabilities: -** a. Steam power plant and its components b. Start-up, operation and shut down of a steam power plant c. Closed steam-water circuit with feed water treatment d. Calibration of sensors e. Determining the: - ➢ Boiler efficiency ➢ Mechanical/thermal efficiency of the turbine ➢ Condenser efficiency ➢ Specific fuel consumption of the plant						
5.		**Gas Turbine Jet Engine with DAQ**	Fuel: - kerosene JET-A1, Kerosene and Paraffin. Axial flow Compressor/turbine Thrust Minimum 150 KN. Sound level at 1 m distance: 130 db or less. Temperature sensors to measure: - Inlet air temperature. Inlet air temperature in the compressor.	Nos	1				

			Fuselage temperature. Combustion chamber temperature. Exhaust gases temperature. Speed sensor to measure the speed (rpm) of the shaft of the turbine Force sensor to measure the thrust of the turbine, range: 0 – 300 N minimum. Pressure sensors to measure: - Static/Stagnation Pressure in the intake gases. Static/Stagnation Pressure at each stage of the compressor. Pressure in the combustion chamber. Static/Stagnation Pressure at each stage of the turbine. Flow sensors to measure: - Inlet air flow. Exhaust gases flow (Pitot with two pressure sensors). Fuel flow. Computer controlled. Data acquisition system. Experimental Capabilities: - a) Study of a gas turbine. b) Function and operation of a gas turbine as jet engine. c) Determination of fuel consumption. d) Determination of air and fuel ratio. e) Recording the relevant parameters of the turbine.						

			f) Determination of the efficiency of the compressor. g) Determination of the turbine thrust. h) Determination of the efficiency of the gas turbine. i) Determination of the gas turbine characteristic curves. j) Determination of the compression ratio of the compressor at k) Different thrust regimes. l) Determination of the gas turbine specific consumption. m) Study of the safety systems in the operation of a gas turbine.						
6.		**Refrigeration Cycle with DAQ**	Open compressor Refrigeration capacity: Min 950W Heater: 1x 1000W Condenser, capacity: Min 1200W Refrigerant R513A, GWP: 631 CO_2-equivalent: 1.3t Measuring ranges Temperature: 9x -30 to 100°C, 1x 0 to 100°C Pressure: 1x -1 to 9bar, 1x -1 to 24bar, 4x -1 to 15bar Torque: (compressor) 0 to 10Nm Speed: (compressor) 0 to 2500min-1	Nos	1				

			Power consumption: (compressor) 0 to 1125W Power: (heater) 0 to 1125W Flow rate: (water) 5 to 70g/s Flow rate: (refrigerant) 0 to 0.5L/min Computer controlled and Data acquisition system. **Experimental Capabilities: -** a. Cyclic process in the log p-h diagram b. Comparison of the real cyclic process and the ideal cyclic process c. Balances at the evaporator and condenser d. Calculation of the motor power via speed and torque e. Determination of losses f. Calculation of the coefficient of performance g. Operating behavior under load h. Non-steady-state operating behavior.						
7.		**Heat Transfer Control Unit with DAQ**	This unit provides AC power for all of the modules. It also provides instrumentation and control capability for all the modules. Calibration capabilities Computer controlled Data Acquisition System.		2				
	7a.	**Linear Heat Conduction Module with DAQ**	Diagram in the front panel illustrating the process. Brass specimens with different diameters. Stainless steel 25 mm of	Nos	1				

			diameter High precision temperature sensors. Electric Heater. High Precision temperature sensors distributed in the module for measurement. Computer controlled. Data acquisition system. Cables and Accessories. Compatible with the main control unit. **Experimental Capabilities: -** a. To study the linear heat conduction of various solid conductors and insulators. b. To demonstrate the thermal conductivity of using different materials with different diameters.						
	7b.	**Radial Heat Conduction Module with DAQ**	Diagram in the front panel illustrating the process. Brass disk of 110 mm of diameter and 3 mm of thickness. Electric heater. High Precision temperature sensors distributed in the module for measurement. Control through computer and PLC. Data acquisition system. Cables and Accessories. Compatible with the main control unit. **Experimental Capabilities: -** a. Determination of the	Nos	1				

			temperature profile b. Determination of the thermal conductivity λ						
	7c.	**Free and Forced Convection Module with DAQ**	Diagram in the front panel illustrating the process. Different heat exchange geometries Flat plate, Cylinder, Tube bundle Heating element for each exchanger. Variable speed Axial fan. High precision temperature sensors. Cables and Accessories. Computer controlled. Data acquisition system. Compatible with the main control unit. **Experimental Capabilities: -** a. Free and forced convection b. Calculation of convective heat transfer at different geometries. c. Experimental determination of the Nusselt number. d. Investigation of the relationship between flow formation and heat transfer during experiments. e. Description of transient heating process.		1				
	7d.	**Extended Surface Heat Transfer**	Diagram in the front panel illustrating the process. Interchangeable fins, with	Nos	1				

		Module with DAQ	different materials like brass and stainless steel. Different cross section shapes: square, circular and hexagonal. High precision temperature sensors. Cables and Accessories. Computer controlled. Data acquisition system. Compatible with the main control unit. **Experimental Capabilities: -** a. To demonstrate the temperature profiles and heat transfer characteristics for extended surface. b. To demonstrate the cooling rate of different materials like brass and stainless steel and cross sectional shapes c. To demonstrate the heat transfer coefficient of different cross sections like square, circular and hexagonal.						
	7e.	**Unsteady State Heat Transfer Module with DAQ**	Diagram in the front panel illustrating the process. Shapes of different materials and diameters. Brass sphere and cylinder with different diameters. Stainless steel sphere and cylinder with different diameters. Aluminum rectangular slab. Stainless steel rectangular slab.	Nos	1				

			High precision temperature sensors. Cables and Accessories. Should be compatible with the main heat transfer control unit. Computer controlled Data acquisition system. **Experimental Capabilities: -** a. Study of the transient heat conduction and convection. b. Study of different temperature/time profiles for different shapes and materials.						
	7f.	**Radiation Heat Transfer Module with DAQ**	Heating element (ceramic). Lamp 150 W with diffuser. Light accessories: Luxmeter Scale: Resolution: Accuracy: 0 to 1999 lux 1 lux 2000 to 19990 10 lux 20000 to 50000 100 lux 8% Selection of light Day, Tungsten, fluorescence or mercury Sensor Photodiode with filter of adjustment of filter Sample frequency: 0.4 s Work temperature: 0 to 50ºC Filters: 3 Grey Neutral Density A153 filters. 1 Grey Neutral Density A152 filter. 1 Grey Neutral Density A154 filter. 3 Filter portholes. Radiometer Elements for studying the	Nos	1				

			radiation and each one contains one temperature sensor Polished aluminum. Anodized aluminum. Brass. 2 Black bodies. Variable slit or aperture to regulate the area of the radiation. High precision temperature sensors. Heating Element. Power measurement (Wattmeter) Radiation measurement. Lux measurement from the luxmeter. Cables and Accessories Computer controlled. Data acquisition system. Compatible with the main control unit. **Experimental Capabilities: -** a. Measurement of the temperature, radiation, intensity light and the power in the heating element or bulb. b. Verify Lambert's inverse-square law c. Verify Stefan-Boltzmann law d. Verify Kirchhoff's law e. Study transient behavior f. Create power balances g. Produce logarithmic						

			diagrams for evaluations						
8.		**Transducers, Instrumentation & Control Teaching Set with DAQ**	Input Transducers: Carbon track. Wire wound & precision rotary potentiometers. Slide potentiometers. NTC thermistors. Type ‘K’ thermocouples. I.C. temperature sensor. Photoconductive cell. Photovoltaic cell. Phototransistor. PIN diode. Linear variable differential transformer. Linear variable capacitor. Strain gauge. Air-flow sensor. Air pressure sensor. Slotted opto-sensor. Reflective opto-sensor. Inductive Proximity Sensor. Hall Effect sensor. Precision servo-potentiometer. Tacho-generator. Humidity sensor. Dynamic microphone. Ultrasonic receiver. Output Devices: Heater. Filament Lamp. DC Motor. Solenoid Air Valve. Ultrasonic transmitter. Buzzer. Loudspeaker. Relay. Solenoid. Counter/timer unit with LED display. Bar graph voltage indicator. Analog 10V center-zero meter. Signal Conditioning Circuits: Buffers. Inverters. Comparator with switchable hysteresis. Amplifiers with gain and offset control. Current amplifier. Summing amplifier. Differential	Nos	1				

			amplifier. Instrumentation amplifiers. AC amplifier. Oscillator 40kHz. Filter 40kHz. Low-pass filter with switchable time constant. Precision full-wave rectifier. Sample and hold circuit. Integrator with switchable time constant. Differentiator with switchable time constant. V/F and F/V converters. V/I and I/V converters. Alarm oscillator with switchable latching. Power amplifier. Electronic switch. Internal Power Supplies: -5V, +5V 1A precision supply. -12V, +12V 1A regulated supply. Pneumatic Supply: Internal Pneumatic pump. D.C. motor, tacho-generator, slotted and reflective opto-sensors for incremental and absolute position, and a 360 degree precision potentiometer with indicator dial for closed-loop position control experiments. System Includes: Trainer. Accessory and Lead Kit. Mains Lead. Curriculum Manual. Student Manual. Instructors Manual. Technical Manual. All Manuals in PDF Format on CDROM. Function Generator. Auto-ranging Digital Millimeter (Qty: 2). Digital Storage Oscilloscope.						
9.		**PLCs Trainer Teaching Set**	To perform a comprehensive range of programming tasks	Nos	1				

			using a programmable logic controller (PLC). Capable of PLC programming in four different IEC 61131 languages a) Ladder Logic b) Sequential Function Chart c) Function Block d) Structured Text with Electro Mechanical Training System demonstrating the positioning and motion processes.						
10.		**Process Control and Instrumentation Apparatus with DAQ**	Material: - Stainless Steel / Acrylic / Metacrylate. All Components should be clearly visible Option to Control through separate PLC / DCS Data Acquisition System. A variable PID/ Controller to see effects of each parameter on the control system 4-20mA, HART, Foundation Fieldbus, Profibus. Must Include the following modules. (a) Level Measurement (b) Flow Measurement (c) Temperature Measurement (d) Pressure Measurement Equipment should be supplied as a set of all modules integrated together in the form of a single working unit if possible.	Nos	1				

			Experimental Capabilities of all Modules: - f. Understanding of the ➢ the level, flow, temperature and pressure sensors/transmitters working principles. ➢ the level, flow, temperature, Pressure Process Plant isometric drawings. ➢ the Instrumentation diagram and wiring of all process plants. g. Operation, calibration and maintenance of level, flow, temperature and pressure sensors and instruments. h. Install instruments according to the instrument mounting drawing. i. Wire transmitter to the controller. j. Configure the controller.						
11.		**Methods to determine the elastic line Mohrs Analogy with DAQ**	Beam Length: 1000mm cross-section: 20x4mm material: steel Weights 7x 1N (hanger), 28x 1N, 21x 5N Measuring ranges force: ±50N, graduation: 1N, travel: 0 to 20mm, graduation: 0.01mm **Experimental Capabilities: -**		1				

			a. Elastic lines for statically determinate or indeterminate beams under load b. Determination of the elastic line of a beam by the principle of virtual work (calculation) c. Mohr's analogy (area moment method devised by Mohr; graphical representation) d. Application of the principle of superposition e. Determination of the maximum deflection of the beam f. Angle of inclination of the beam g. Comparison between calculated and measured values for angle of inclination and deflection						
12.		**Buckling behavior of Bars with DAQ**	Test bars Quantity: 11 Bar lengths: 350 to 700mm or more Materials: aluminum, copper, brass, steel, GFRP Cross-sections: 10x4mm, 25x6mm, 25x10mm Load spindle Force: max. 2000N Stroke: max. 10mm Lateral deflection: max. 20mm Sample holder hole diameter: Ø 20mm		1				

			Weight for lateral load: max. 20N 1x 5N (hanger), 3x 5N Measuring ranges Force: 0 to 2500N, graduation: 50N deflection: 0 to 20mm, graduation: 0.01mm **Experimental Capabilities: -** a. Investigation of buckling behavior under the influence of ➢ different supports and clamps. ➢ different bar lengths and cross-sections ➢ different materials. b. Testing Euler's theory, buckling on elastic bars. c. Calculation of the expected buckling force with Euler's formula d. Measurement of force and deflection						
13.		**Deformation of Straight Beams with DAQ**	3 steel beams with different cross-sections 1 brass and 1 aluminum beam 3 articulated, height-adjustable supports with force gauge 1 support with clamp fixing force gauges can be zeroed 3 dial gauges to record deformations weights with adjustable hooks anodized aluminum section frame housing the experiment storage system to house the components	Nos	1				

			Beam length: 1000mm Cross-sections: 3x20mm (steel), 4x20mm (steel), 6x20mm (Steel, Brass, Aluminum) Frame opening: 1320x480mm Weights 4x 2.5N (hanger), 4x 2.5N, 16x 5N Measuring ranges Force: ±50N, graduation: 1N Travel: 0 to 20mm, graduation: 0.01mm **Experimental Capabilities: -** a. Investigation of the deflection for statically determinate and statically indeterminate Straight beams Cantilever beam, Single-span beam, dual- or triple-span beam b. Formulation of the differential equation for the elastic line c. Deflection on a cantilever beam d. Measurement of deflection at the force application point e. Deflection of a dual-span beam on three supports f. Measurement of the support reactions g. Measurement of the deformations h. Influence of the material (modulus of elasticity)						

			and the beam cross-section (geometry) on the elastic line i. Application of the principle of virtual work on statically determinate and indeterminate beams j. Determination of lines of influence Arithmetically						
14.		**Combined Bending and Torsion Loading with DAQ**	3 beams: I, L and U profiles Clamping flange with angle scale to indicate the angular position of the beam Eccentricity of load application point adjustable. 2 dial gauges with bracket to record the horizontal and vertical deformation of the beam under load Storage system to house the components Aluminum beam Deformed length: 500mm Eccentricity of load application point: 0 to 25mm Dial gauges 0 to 10mm, Graduation: 0.01mm Angle scale 0 to 360°, Graduation: 1° Weights 1x 2.5N (hanger), 1x 2.5N , 3x 5N **Experimental Capabilities: -** a. Product moment of inertia and axial second moment of area. b. Bernoulli hypothesis.	Nos	1				

			c. Symmetrical bending on a beam (uniaxial) ➢ with I-profile ➢ with L-profile ➢ with U-profile d. Unsymmetrical bending (complex) on a beam. e. Combined bending and torsion loading by way of eccentric force application. f. Determination of the shear center on a beam with a U-profile. g. Familiarization with shear flow (shear forces in a cross-section) h. Comparison of calculated and measured values						
15.		**Gauge factor measurement Apparatus of Strain Gauge with DAQ**	Bending bar with 2 strain gauges on the compression side and tension side respectively. Strain gauge configured as full bridge 2-point ball bearing mounting of bar permits purely bending load application Mechanical load application device. Dial gauge with adjustable dial for direct measurement of deflection Measuring amplifier with 4-digit digital display. Bending bar made of steel: 660x25x12mm	Nos	1				

			Strain gauge application full bridge, 350 Ohm Two strain gauges on the top and underside of the bar respectively. Amplifier measuring range: ±2mV/V Resolution: 1µV/V Zero balancing adjustment range: ±1mV Dial gauge 0 to 20mm Graduation: 0.01mm **Experimental Capabilities: -** a. Fundamentals of measurement using strain gauges. b. Determination of the gauge factor of strain gauges.						
16.		**Stress and Strain analysis on a thin walled cylinder with DAQ**	Aluminum vessel Length: 400mm Diameter: Ø=75mm Wall thickness: - 2.8mm Internal pressure: - max. 3.5N/mm^2 (35bar) 5 strain gauges: half-bridges, 350 Ohm Angular position to the vessel axis: 0°, 30°, 45°, 60°, 90° Gauge factor: 2.00 ±1% Manometer 0 to 40bar accuracy: class 1.0 **Experimental Capabilities: -** a. Determination of the principal stresses: axial and circumferential stresses by magnitude and direction.	Nos	1				

			➢ in an open vessel (pipe) ➢ in a closed vessel (boiler) b. Comparison of open/closed vessels c. Determine Poisson's ratio d. Investigation of relations between strains, pressure and stresses in a plane biaxial stress state.						
17.		**Torsion Testing Machine with DAQ**	Torque: - 10-500Nm. Grips: - 3 or 4 jaws chucks, key type chuck, keyless type chucks, collet grips, T-slot round platen, custom grips and fixtures Rotations: - 1000 times or 360'000° clockwise and counter-clockwise. Control: - Angle or torque closed loop control. Torque Accuracy: - In accordance with ISO 7500-1 and EN 10002-2, Grade 0.5. Torsion load Cell Data acquisition system. Computer Controlled. Test Specimens of different cross sections, diameters and materials. **Experimental Capabilities: -** a. Shear modulus of	Nos	1				

			elasticity and second polar moment of area. b. Angle of twist dependent on clamping length. c. Angle of twist dependent on torque d. Influence of rigidity on torsion. e. Calculation of angle of twist. f. Comparison of calculated and measured angle of twist.						
		Total							

Bid Bond Ref______________________

Total Gross Value________________________

*Custom duty is to be quoted separately.

**Bid Bond to be attached with Annex C. Copy of Bid Bond be attached with Technical offer without showing its value)

Firm Name________
Signature__________
Name_____________
Designation___________