TENDER DOCUMENTS

Mechanical Lab Equipment

NUTECH / SCM / Mechanical Lab Eqpt (Ph-IV) 2020 / TD-151

NATIONAL UNIVERSITY OF TECHNOLOGY

TENDER NOTICE

National University of Technology (NUTECH)

NUTECH / SCM / Mechanical Lab Eqpt (Ph-IV) 2020 / TD-151 &

NUTECH / SCM / Electrical Lab Eqpt (Ph-IV) 2020 / TD-152

1. Sealed bids are invited from Government / FBR Registered Firms for the procurement of Lab Equipment for NUTECH on **CPT Basis**.

2. Tender documents containing terms, conditions and detailed specifications of items (including draft contract) can be downloaded from NUTECH website "https://nutech.edu.pk/downloads/procurement/scm-tenders/ w.e.f **21 August 2020**.

3. Quotations shall be submitted as per requirement of the tender documents.

4. Bidders will be required to submit **Bank Draft / CDR** equal to **5%** of quoted value as Bid Bond in favor of National University of Technology (NUTECH).

5. Submit Rs 1500/- as Tender fee in favor of NUTECH HBL Account (**NUTECH Tendering and Contracts, 5037-7000210755).** Please attach bank receipt with technical offer. Offers will not be entertained without payment of processing fee.

6. Details for Submission & Opening of bids for each tender are as under:-

Ser	Description	Submission	Tender Opening	Completion Days
a.	Mechanical Lab Equipment (TD-151)	1030 hrs on 23 Sep 2020	1100 hrs on 23 Sep 2020	120 Days
a.	Electrical Lab Equipment (TD-152)	1130 hrs on 23 Sep 2020	1200 hrs on 23 Sep 2020	120 Days

Deputy Director (Supply Chain Management)

NATIONAL UNIVERSITY OF TECHNOLOGY, IJP ROAD, I-12, ISLAMABAD

Tel: 0092-51-5476768, Ext: 227

NATIONAL UNIVERSITY OF TECHNOLOGY

SUPPLY CHAIN MANAGEMENT

INVITATION TO TENDER

Tender submission time: 1030 hours, 23 September 2020

1. NUTECH desires to procure the list of item(s) / Store(s) on **CPT** basis. as per **Annexure-A**. Interested bidders are requested to send their bids through courier or deliver at NUTECH under "Single Stage – Two Envelopes" (two envelopes placed together in third envelope), marked clearly as **"Technical Offer"** and **"Commercial Offer"** respectively to the undersigned, latest by or before above mentioned due date.

2. **Conditions Governing Contracts.** The contract made as result of this IT will be in accordance with the draft contract published on NUTECH University website and other special conditions (Mentioned in this document) that may be added to given contract for the supply of Lab Equipment.

3. **Delivery of Tender.** The offer is to be submitted as under:-

   a. **Technical Offer.** Technical Offer should contain only Annexure-A, Annexure-A-1 & Annexure B duly filled in (supported with relevant technical literature / details / catalogues etc) and receipt of tender processing fee. Copy of bid bond WITHOUT MENTIONING PRICE should be attached with technical offer. Only relevant technical details i.e literature/brochures) without mentioning the financial aspect of the offer in DUPLICATE should be enclosed in an envelope. In technical proposal, all items must have the brand names, model number, manufacturer's name, country of origin, manufacturer's warranty including parts with complete specs and brochures. Re-conditioned and re-furbished equipment shall not be acceptable. Following information will be clearly marked on the envelope:

      (1) Technical Offer
      (2) Original Performa Invoice (without price)
      (3) Tender number
      (4) Date/ time of opening

b. **Commercial Offer.** Commercial Offer will contain Annexure-C and bid bond (Dully mentioned and placed in separate envelope. The offer indicating the quoted price (IN USD only) in figures as well as in words along would be enclosed in an envelope. Following information will be clearly marked on the envelope.

(1) Commercial Offer

(2) Original Performa invoice with price

(3) Tender number

c. Both the envelopes i.e. commercial offer and technical offer would be enclosed in yet another properly sealed envelope that will be marked with address of this office only. There should be clear indication that this envelope contains tender documents.

d. The tender duly sealed will be addressed to the following:-

Deputy Director (Supply Chain Management Office)
NATIONAL UNIVERSITY OF TECHNOLOGY (NUTECH)
I J P ROAD, I-12, ISLAMABAD
Tel: 0092-51-5476768, Ext: 227

4. **Date and Time for Receipt of Tender.** Sealed bids with detailed specifications should reach SCM office latest by **1030 hours on 23 September 2020.** Delay occurring in post shall not be accepted. Tenders received after the appointed / fixed time will NOT be entertained. The appointed time will, however, fall on next working day in case of closed / forced holiday.

5. **Tender opening.** The offers shall be opened 30 minutes after submission time**.** Commercial offers will be opened at later stage if Technical Offer is found acceptable on examination by technical authorities. Date and time for opening of commercial offer shall intimated later. Only legitimate / registered representatives of firm will be allowed to attend tender opening.

6. **Validity of Offer.** The validity period of quotations must be indicated and should be 90 days from the date of opening of financial offer.

7. **Documents.** Following information / copy of documents must be provided / attached with offer:-

a. A copy of letter showing firm's financial capability.

b. NTN/GST number be mentioned on the offer and copy of registration Certificate issued by Sales Tax Department, attached.

c. Foreign supplier to provide its Registration Number issued by respective Department of Commerce authorizing export of subject stores**.**

d. Annexes A, A-1, B and C and special conditions must be signed and stamped. ATTACH ONLY RELEVANT DOCUMENTS.

e. Complete all Annexes as per given format. Do not use your format or letter head. Offer may be rejected if given format is not followed.

f. OEM/principal agency agreement must be provided.

8. **Disqualification.** Offers are liable to be rejected if:-

a. Validity of offer is not quoted as required in IT documents.

b. Any deviation from the General/ Special / Technical Instructions.

c. Offers are found conditional or incomplete in any respect.

d. Copy of EM/Bid Bond & Tender processing fee (with tech offer) and original EM/Bid Bond (with fin offer) are NOT attached.

e. Multiple rates are quoted against one item.

f. Manufacturer's relevant brochures and technical details on major equipment assemblies are not attached in support of specifications.

g. Offer received later than appointed / fixed date and time.

h. Subject to restriction of export license.

i. Offers (Commercial / technical) containing non-initialled / unauthenticated amendments / corrections / overwriting. If the validity of the agency agreement has expired. The commercial offer against FOB / CIF / C&F tender quoted in local currency.

j. If the offer is found to be based on cartel action in connivance with other sources/participants of the tender.

9. **Earnest Money / Bid Bond.** Commercial Offer must be accompanied with a Bid Bond (CDR/Pay Order/Bank Draft) in agreement of faithful compliance of the conditions of Contract. This amount will be equivalent to 5% of the total quoted value. The Bid Bond amount submitted by the successful bidder will however be refunded on effective termination of Contract. (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. Bid Bond will be used as performance guarantee till the delivery of stores, otherwise separate performance guarantee valued at 5 % of contract will be submitted by successful firm till stores are delivered and inspected.

10. **Return of Earnest Money/Bid Bond.**

a. Bid Bond to the unsuccessful bidders will be returned on finalization of the lowest evaluated bidder.

b. Bid Bond of the successful bidder/bidders will be returned on submission of Bank Guarantee/Bid bond against warranty period OR Bid bond retained for the warranty period as the case may be.

11. **Terms of Payment/ LC Charges** In CPT/FOB cases (all categories) payment will be made through letter of credit (LC). LC opening charges in Pakistan are to be borne by NUTECH. Payment will be made through irrevocable LC in favour of Manufacturer. Payment will be in USD.

12. **Bank Guarantee (BG)**.In case where equipment is backed by warranty, the BG submitted equal to 05% of FOB/FOR/CPT etc value shall remain valid for up to 60 days beyond completion of warranty period.

13. **Insurance:-** Insurance will be NUTECH's responsibility through NICL.

14. **Freight charges /Misc charges:** All charges such as packing, forwarding, local freight, loading and unloading, installation and commissioning, custom clearance, orientations, on job training or any other will be part of quoted price. Delivery till NUTECH will be firm's responsibility and all associated costs will be part of quotation as well.

15. **Warranty**. All goods /store offered would be brand new, from current year of production and will be governed as per warranty clause. The warranty period may be covered by BG as depending on the value /criticality of the tender equipment.

16. **Delivery Schedule.** Store will be delivered within **120 Days** from contract signing date.

17. **Force Majeure.** If non-compliance with the period of delivery or services can be proved to be due to Force Majeure, such as but not limited to mobilization, war,

riot, strike, lockout or the occurrence of unforeseen events, the period shall be reasonably extended.

18. **Subletting** Suppliers are not allowed to sublet wholly or part of the contract to any other firm /company without prior permission by NUTECH. Firm found in breach of the clause will be dealt with as per purchaser's right and discretion.

19. **Arbitration.** The dispute shall referred for adjudication to a board comprising of Pro-Rector NUTECH as Chairman and two arbitrators, one to be nominated by each party. The arbitration proceeding shall be held in Pakistan under Pakistan Law. The venue of arbitration shall be the place from which the contract is issued or such other place as the purchaser at his discretion may determine. Arbitration award so given will be firm and final.

20. **Export License/Permit /End User Cert.** It shall be the responsibility of the Supplier to obtain from the Government concerned all permits and export licenses, etc required to enable each consignment to be shipped immediately as per the delivery schedule. In case the supplier fails to arrange export license within 30 days of signing the contract the purchaser reserves the right to cancel the contract on the risk and expense of the supplier without prior notice. The purchaser will provide End User Certificate for acquisition of export license to the supplier (format to be provided by the supplier for respective country within 10 day of signing of the contract).

21. **Technical Specification:** The supplier will provide OEM certificate, quality certificate /inspection document to the purchaser confirming the quality of the product being supplied under this contract .Store must bear the manufacturer's identification marking /monogram.

22. **Inspection /Testing of Store**: Inspection testing will be carried out at NUTECH by the concerned inspection team as detailed by the respective department in accordance with the laid down Acceptance Criteria. (Acceptance Test Procedure (ATPs)/Drawing /Test standard and specification). **The supplier will provide ATPs with technical offer**. Mutually agreed/approved ATPs will form part of contract to govern the inspection of store subsequently.

23. **Requirement of Samples.** The requirement of tender sample will be included in the case if required for evaluation by technical authorities'. Beside this advance sample if required will be also made part of the IT as well as the contract.

24. **Change In Specification / Mfr / Model.** No alternation marked/brand and quality of store will be entertained after the tender have been opened.

25. **Checking of Store at Consignee End.** All stores will be checked at Consignee's end in the presence of the supplier's representative. If for some reason, the supplier decides not to nominate his representative for such checking, an advance written notice to this effect will be given by the supplier to the consignee prior to immediately on shipment of store. In such an event the supplier will clearly undertake that decision of consignee with regard to quantities and description of consignment will be taken as final and discrepancy found will be accordingly made up by supplier. In all other cases the consignee will inform the supplier about arrival of consignment immediately on receipt of store through registered email/letter and telephone. If no response from the supplier is received within 15 days from initiation letter the consignee will have the right to proceed with the checking without supplier's representative .Consignee's report on checking of the stores will be binding on the supplier in such cases.

26. **Packing /Marking.** The supplier shall be responsible for proper packing of the Store in standard export packing worthy of transportation by sea /air /road rail so as to ensure their content being free from lose or damages due to faulty packing on arrival at the ultimate destination. Packing of stores will be done at the expenses of the supplier. All packing cases, containers and other packing material shall become the property of the NUTECH on receipt. Any loss occurred /demurrage paid due to wrong marking will be made good by the supplier

27. **Original Performa Invoice**: Original Performa invoice must have following components incorporated:-

a. HS Code
b. Incoterm
c. Payment Terms
d. Origin of good
e. Port of shipment

f. Address of OEM

g. Seller acceptance (on Performa Invoice)

h. Invoice Date

i. Latest date of shipment

j. Seller complete bank detail

Note: Performa Invoice in the name of NUTECH in case of FOB cases & in the name of local partner in case of FOR cases.

28. **General Instructions:** Following must be noted:-

a. The firm should provide point to point acceptance of each clause of IT and special instructions attached with IT.

b. Firm will render a certificate with technical offer that firm is neither defaulter nor blacklisted by any Government / semi Government organization directly or indirectly.

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

d. **2 years** warranty against **5% Bank Guarantee/CDR/Pay Order/ bank Draft** of the store value will be required from the successful bidders from the date of commissioning as performance bond.

e. The stipulated delivery period should be strictly adhered to. Any anticipated delay that is beyond the control of Seller will be informed (in writing) well in advance of the expiry of the due date of the activity along with reasons thereof, requesting for the grant of extension in delivery period. If the Seller fails to do so, or the Buyer is not convinced with the rationale provided by the Seller, Liquidated Damages up to/at 2% per month or part thereof, will be imposed. However, the maximum limit of the Liquidated Damages will not exceed 10% of the delayed store value.

f. If even after applicability of 10% LD, the Seller fails to deliver the required stores, the Buyer will be at liberty to Cancel the contract, and /or procure the stores from an alternate source, on the Seller's "Risk & Cost/Expense". In that case, the Seller will be bound to make payment to the new source through NUTECH. The purchaser’s decision under this clause shall NOT be subjected to arbitration.

g. NUTECH reserves the right to cancel the Contract without assigning

any reason whatsoever during its currency / execution / after placement, if the firm is found to be involved in any dubious activity, litigation, lacking to meet contractual obligations with the purchaser or is blacklisted with any other Public procurement agency. No claims / loss /damage of whatsoever nature shall be entertained and NUTECH's decision in this regard will be final / binding on the Seller.

h. An appropriate amount may be paid for mobilization against Bank Guarantee/CDR/Demand Draft/Pay Order.

i. Firms with previous pending/outstanding projects/business with NUTECH may not be considered for award of this tender.

Deputy Director
Supply Chain Management Office

Annex-A

Technical Specifications

NUTECH / SCM / Mechanical Lab Eqpt (Ph-IV) 2020 / TD-151

Ser	Part No	Items	Description	A/U	Country of Origin	Qty Req	Bidder Compliance	
							Yes	No
1		**Stress and strain analysis on a membrane (Diaphragm) with DAQ System and Software**	• Bench-top unit. • Anodized aluminum frame and made of painted steel • Should be able to measure effect of pressure on surface profile of a diaphragm (membrane) • Electrical-resistance precision strain gauges for measuring diaphragm strains • Switch to tare the deformation measurements. • Strain gauges connectors. • Digital display for the deformation measurement. • Self-contained, hand-operated hydraulic pressurizing system for accurate pressure control • Pressure: Displayed by Bourdon gauge • Surface profile measurement provision though digital indicators, • Strain: Measured by electrical resistance gauges and displayed digitally • Cylinder Oil: SL Hydraulic Oil • Diaphragm material: Aluminum alloy to BS6082-T6 or equivalent • Diaphragm nominal thickness: 3.0 mm approximate • Diaphragm Dimensions;	No	EU /USA	1		

			• Nominal diameter = 200 mm approximate or higher
			• Nominal thickness = 3 mm approximate
			• Young's Modulus 69 GN/m^2 or higher
			• Poisson's Ratio 0.33 approximate or better
			• Maximum Pressure: 75 kN./m^2 approximate
			• At least 2x Circumferential gauges, 2x Radial gauges out of these 1x at 45
			• Approximate no of Strain Gauges: 8
			• Gauge factor: 2 ±0.5% Minimum
			• Dial gauge range 0-25 mm or better
			• Manometer 0-1 bar or better
			• DAQ for recording experimental data and for measuring and displaying
			• DAQ System must operate on LabVIEW software and must have
			  ○ Computer connection : USB 2.0 or better including lead and connectors like shielded twisted pair cables, and other essential accessories for connecting system to Computer
			  ○ Sample rate 20 kHz with 12 bit resolution or higher
			  ○ Bandwidth/Filter cut-off 3 kHz (nominal)
			  ○ Data Export to XLSX and HTML files
			Experimental Capabilities:-
			• Measure radial and tangential strain using strain gauges.
			• Measure deflection using a dial gauge.
			• Calculate the stresses from the measured strains: radial stress, tangential stress.
			• Determine direction of principal stress.
			• Application of Mohr's strain circle to determine the principal strains.					

			• Measure circumferential and radial strains of a diaphragm under pressure					
2.		**Heat Exchanger Base Service Unit Apparatus with DAQ System, Software and following modules**	• Common unit for various modules as mentioned in the list. • For heating, pumping the water and controlling the direction of water flows and for measuring temperature, and flow rates of Cold and hot water • Covered Stainless steel tank (Min capacity 30 L), with Electric heating element (approximately 3000 W), thermostat for heating water, ("J" type Temperature sensor, mechanism to control the water level, drain valve • Variable speed Centrifugal pump with range 0 – 3 l/min or more. • Flow sensors for hot and cold water, range: 0.25 – 5 l/min or higher. • Control valves for the cold and hot water. • Four ball valves for controlling co-current or counter-current flux in the exchanger. • Two ball valves to control and drain the hot water of the base unit. • Maximum pressure in exchangers 0.6 bar with regulator • Flexible tubes to connect with the different exchangers. • DAQ System must be based upon National Instruments Data Acquisition Board for o Real time curves representation about system responses o Real time PID control for parameters	No	EU /USA	1		

			involved in the process ○ Analog input with 16 channels and Sampling rate up to: 250 KS/s (kilo samples per second) ○ Analog output with 2 Channels and Maximum output rate up to: 900 KS/s ○ Digital Input / Output with 24 channels • The equipment and related software must be compatible with heat exchanger modules of Edibon Spain available at the lab and all modules demanded below (2a to 2d) ○ Extended Concentric Tube Heat Exchanger ○ Extended Plate Heat Exchanger ○ Shell and Tube Heat Exchanger					
	2a	**Cross Flow Heat Exchanger with DAQ System and Software**	• Compatible with Item S No 2 • Robust, bench-mounting product • Anodized aluminum frame and panels made of painted steel. • Main metallic elements made of stainless steel. • Rectangular duct of approximate 800 x 200 x 200 mm • Radiator located across the air duct • Heat transfer area of radiator not less than 30000 mm². • Axial fan with maximum air velocity of 4 m/s. • Four “J” or “K” type temperature sensors to measure input and output water and air temperatures. • Velocity sensor to measure air velocity, range: 0 – 5 m/s. • Heating Element Power: Min 100W	No	EU /USA	1		

			• PID Computer Control, Data Acquisition and Data Management Software • Softwares as part of the SCADA system and compatible with actual Windows operating systems. • Graphic and intuitive simulation of the process in screen. • Compatible with the industry standards. • Registration and visualization of all process variables in an automatic and simultaneous way • Sampling velocity up to 250 KS/s (kilo samples per second). • Calibration system for the sensors involved in the process. **Experimental Capabilities:-** • Introduction to the concept of psychometric properties. • Effect of temperature differential on the heat transfer coefficient. • Overall energy balance in the heat exchanger and study of losses. • Determination of the exchanger effectiveness (NTU method). • Calculating the inlet and mean velocity • Influence of air and water flow on the heat transfer. • Reynolds number calculation.					
	2b	**Jacketed Vessel Heat Exchanger**	• Compatible with Item S No 2 • Unit to study heat transfer between hot water	No	EU /USA	1		

		with DAQ System and Software	flowing through a jacket and cold water contained in a vessel • Anodized aluminum frame and panels made of stainless steel • Heating of constant mass of water in vessel • Measurement of temperature at inlet and outlet of the exchanger in cold and hot water • Baseplate with clear schematic of experiment • Connection to service module with quick connector • Vessel total volume: Approx. 15L • Interior vessel volume: Approx. 7.5L • Jacket volume: Approx. 7.5L • 4-7 Temperature sensors “J” type or ”K” type • 2-3 sensors for measuring cold water temperature • 3-4 sensors for measuring hot water temperature • PID Computer Control, Data Acquisition and Data Management Software • Softwares as part of the SCADA system and compatible with actual Windows operating systems. • Graphic and intuitive simulation of the process in screen. • Compatible with the industry standards. • Registration and visualization of all process variables in an automatic and simultaneous way • Sampling velocity up to 250 KS/s (kilo samples per second). • Calibration system for the sensors involved in the process.					

			Experimental Capabilities:- • Determination of the exchanger effectiveness NTU method • Influence of the flow on the heat transfer • Calculation of the Reynolds Number • Influence of the vessel stirring on the heat transfer when operating in batches • Influence of vessel's water volume on the heat transfer when operating in batches • Study of pressure drop in the exchanger • Global balance of energy in the heat exchanger and losses study.					
	2c	**Coil Vessel Heat Exchanger with DAQ System and Software**	• Compatible with Item S No 2 • Unit to study heat transfer between hot water flowing through a coil and cold water contained in a vessel • Anodized aluminum frame and panels made of stainless steel • Heating of constant mass of water in vessel • Measurement of temperature at inlet and outlet of the exchanger in cold and hot water • Baseplate with clear schematic of experiment • Connection to service module with quick connector • Overflow or PVC glass tube • Coil: Copper or stainless steel • Length of coil: Approx. 2m • Inside Dia: Approx. 4mm • Outside Dia: Approx. 6mm • Electric stirrer • 4-7 Temperature sensors "J" type or "K" type • 2-3 sensors for measuring cold water temperature	No	EU /USA	1		

			• 3-4 sensors for measuring hot water temperature • PID Computer Control, Data Acquisition and Data Management Software • Softwares as part of the SCADA system and compatible with actual Windows operating systems. • Graphic and intuitive simulation of the process in screen. • Compatible with the industry standards. • Registration and visualization of all process variables in an automatic and simultaneous way • Sampling velocity up to 250 KS/s (kilo samples per second). • Calibration system for the sensors involved in the process. **Experimental Capabilities:-** • Global balance of energy in the coil heat exchanger with coil and losses study • Determination of the exchanger effectiveness NTU method • Influence of the flow on the heat transfer • Calculation of the Reynolds Number • Influence of the vessel stirring on the heat transfer when operating in batches • Study of pressure drop in the exchanger					
	2d	**Turbulent Heat Exchanger with DAQ system and Software**	• Compatible with Item S No 2 • Unit to study the heat transfer between hot water and cold water. • Hot water circulates through an internal tube • Cold water flows through the annular zone	No	EU /USA	1		

			between the internal and the external tube. • Exchanger should operate with co-counter and counter current flows • Anodized aluminum frame and panels made of painted steel. • Main metallic elements made of stainless steel • Three to four segmented baffles • Exchanger should measure cold water and hot water temperatures at different points of the exchanger • Diagram in the front panel with distribution of • the elements • Outer tube Length: 500mm approx. • Internal Dia: 60 mm approx. • External Dia: 50mm approx. • Internal tubes made of stainless steel or copper • Internal tube bundles: min 4 bundles of tubes having L: 500mm approx. • Internal Dia: 4-6 mm approx. • External Dia: 6-10 mm approx. • Internal heat transfer area, Ah= 0.0377 m^2 approx. • External heat transfer area Ac= 0.0471 m^2 approx. • Min 6 “J” or “K” type temperature sensors • PID Computer Control, Data Acquisition and Data Management Software • Softwares as part of the SCADA system and compatible with actual Windows operating systems. • Graphic and intuitive simulation of the process in screen.					

			• Compatible with the industry standards. • Registration and visualization of all process variables in an automatic and simultaneous way • Sampling velocity up to 250 KS/s (kilo samples per second). • Calibration system for the sensors involved in the process. **Experimental Capabilities:-** • Global energy balance in the heat exchanger and the study of losses. • Exchanger effectiveness determination. NTU Method. • Study of the heat transfer under counter-current and co-current flow conditions. • Flow influence on the heat transfer. • Reynolds number calculation • Obtaining of the correlation that relates Nusselt number with Reynolds number and Prandtl number. • Obtaining of the heat transfer coefficients by convection					
3		**Marcet Boiler with DAQ System and Software**	• A compact, bench top unit for observing pressure and temperature relationship for saturated steam • Anodized aluminum frame with panels made of painted steel • Stainless Steel vessel (boiler) with observation window • The corrosion-resistant high grade stainless steel boiler must comply with the latest European safety standards • Metallic elements made of stainless steel	No	EU /USA	1		

			• Filling cap, Drain Valves and safety key
			• Unit be protected by transparent sheet to allow handling of valves
			• Experiment Pressure range: Approximate 10-15 bar (absolute)
			• Approximate Maximum Pressure 12.5 bar absolute (11.5 bar gauge) controlled through Relief Valve
			• Boiler Volume: Minimum 1.7 liters
			• Heater Power : Min 1 kW
			• Maximum Experiment Temperature: Approx 170º
			• Electric Heater Thermal Cutout: Approx185ºC or higher
			• DAQ System must have
			  ○ Computer connection : USB 2.0 or better including lead and connectors like shielded twisted pair cables, and other essential accessories for connecting system to Computer
			  ○ Bandwidth/Filter cut-off 3 kHz (nominal)
			  ○ Data Export to XLSX and HTML files
			• Electronic sensors measure boiler temperature and pressure - shown on a digital display in both SI and traditional units (including absolute values)
			• Electric Heater with thermostat to limit the maximum heater temperature.
			• Safety features like temperature cut-out switches and a pressure relief valve with appropriate range
			• Electronic sensors for measuring boiler temperature and pressure (absolute and gauge)					

			• A mechanical Bourdon type gauge to independently display the pressure even in case of electricity failure **Experimental Capabilities:-** • Variation of saturated steam pressure with temperature • Confirmation of the Antoine Equation • Comparison of the obtained saturation curves with the theoretical values. • Experimental determination of Clausius-Clapeyron equation for saturated steam and its comparison with theoretical results • Determination of the error percentage between experimental and theoretical (dT/dP) for saturated steam					
4		**Creep Testing Machine with DAQ System and Software**	• A self-contained bench mounting machine for demonstration of phenomenon of creep under different conditions and in different materials • Bench top unit with adjustable legs • Anodized aluminum structure and panels in painted steel • A long lever arm and a bearing as a pivot point • Lever mechanical advantage not less than 8:1 • Dial indicator for measuring elongation of the specimen • Enclosure for surrounding the specimen area to maintain a constant temperature • Typical test times for lead specimens to be from approx. 4 minutes to >18 hours at around 20°C • Thermocouple to measure the temperature effects of creep • Thermometer range -10°C to 50°C • A cool pack to reduce specimen temperature	No	EU /USA	1		

			• DAQ system: Displacement sensor, computer interface unit and software to monitor the displacement up to failure by computer
			• Must operate on LabVIEW software and must have
			  ○ Computer connection : USB 2.0 or better including lead and connectors like shielded twisted pair cables, and other essential accessories for connecting system to Computer
			  ○ Sample rate 20 kHz with 12 bit resolution or higher
			  ○ Bandwidth/Filter cut-off 3 kHz (nominal)
			  ○ Data Export to XLSX and HTML files
			• Following models / specimens or their equivalent in minimum quantity 40 each must be supplied with the machine
			  ○ Lead Creep Specimen with Strain hardening coefficient n = 10, Activation energy for creep Q = 120 kJ/mol
			  ○ Polypropylene Creep Specimen with Young's modulus = 1250 N/mm^2 and Time Exponent k = 0.1 to 0.2
			  ○ Nylon 66 Creep Specimen
			  ○ Unplasticised PVC Creep Specimen
			• Weights and weight hangers
			  ○ 1x 100 g weight
			  ○ 2x 200 g weights
			  ○ 3x 500 g weights
			Experimental Capabilities:-
			• Demonstration of three phases of creep
			• Demonstration of effect temperature on creep
			• The normal breaking load of a specimen over a fixed time
			• Relationship between breaking load and time					

			for lead specimens • Time extension curves to show the three phases of creep (primary, secondary and tertiary) • The effect of temperature on the creep rate of specimens					
5		**Fatigue in Rotating Bending Study Unit with DAQ system**	• Bench top unit • Anodized aluminum frame and panels made of painted steel • Four adjustable feet dampers • Transparent cover • Metallic electrical box • Control panel in front having ○ Disconnector, ○ main circuit breaker, ○ differential, emergency stop, ○ general start-stop with light indicator, ○ on/off motor, ○ LED motor condition and general electrical supply ○ Digital display of the number of cycles before rupture / reset by button • LCD display of the number of cycles before rupture / reset by button with frontage • Three phase asynchronous motor 2850 rev/min or higher. • Shaft guided by ball bearings • A conical clamping chuck for immobilization of test tube • Inductive detector for counting the number of test cycles • Device for application of the force: ○ Thumbwheel for adjusting the force exerted of the test tube extremity up to 35 kg	No	EU /USA	1		

			○ Dynamometer for measuring the effort ○ Mechanical detector of test tube for automatic stopping of counting the number of cycles • Maximum stress: Approximately 350 MPa • Maximum cycle count: 9.99 x 108 with a one cycle resolution • DAQ System for capturing the data to be shown on computer interface • Force applied should be varied between 0 - 200N • Specimens with compatible length and different diameters to be Included like: ○ Min. 40 RF1010 (steel) or equivalent ○ Min. 40 RF1020 (aluminum) or equivalent ○ Min. 40 RF1030 (brass) or equivalent • Few samples should have different notches • The unit includes all the safety measures required for a safe operation: ○ Metallic protective cages, a fixed one for the motor axis outlet and a removable one for the test piece zone; ○ The unit should not work without these covers to avoid accidents. ○ Automatic shut down in case of the test piece breakage. **Experimental Capabilities:-** • Identification of parameters inducing the rupture by fatigue • Determination of the basic principles of fatigue strength testing • Influence of the material on fatigue strength • Curve plotting S-N Wohler					

			• Statistical approach for measurement of the fatigue • Counting the number of cycles at the rupture. • Calculating the number of test cycles • Influence of the section on fatigue strength • Influence of different curvature radii and surface finish on fatigue • Influence of the notches and surface finish on fatigue strength					
6		**Conductivity of Liquid and Gases**	• Unit to determine thermal conductivity of liquids and gases • Anodized aluminum frame and panels made of painted steel • Cylinder with brass jacket containing the test fluid and refrigeration water • Variable heating element in the cylinder • Heating element with min power of 100W controlled by computer • Digital display of heating power • Min 6High precision Temperature sensors “K” or “T” type thermocouples • Cylinder length: Appox 0.1m • Flow sensor to measure the cooling water flow range: 0.1 to 8 l/min. • Water flow regulation valve • Baseplate with clear schematic of experiment layout • On/Off button • Potentiometer • Compatible with following liquids and gases: • Dry Air • Castor Oil • Carbon Dioxide (CO_2) • Softwares as part of the SCADA system and	No	EU /USA	1		

			compatible with actual Windows operating systems. • Graphic and intuitive simulation of the process in screen. • Compatible with the industry standards. • Registration and visualization of all process variables in an automatic and simultaneous way • Sampling velocity up to 250 KS/s (kilo samples per second). • Calibration system for the sensors involved in the process. • The equipment and related software must be compatible with Heat Transfer Base Unit of Edibon Spain available at the lab **Experimental Capabilities:-** • Determination of thermal conductivity of different liquids and gases • Obtaining of the curve of thermal conductivity of the air. • Determination of Thermal conductivity in vacuum • Water thermal conductivity determination • Thermal conductivity determination of a mineral oil • Calibration of Unit • Thermal conductivity of dry air					
7		**Transducers Trainer**	• The Trainer shows most of the devices used in the industry that allow the electronic systems to communicate with the real world, to measure physical variables and to control industrial processes. • Input Transducers for converting analog signal into an electrical one and evaluation of these	No	EU /USA	3		

			transducers, with their characteristics, adjustments and practical applications can be made. These include:- ○ Resistance Transducers for applications in angular or linear position like Linearly sliding potentiometer, Rotary carbon-track potentiometer, Rotary coil potentiometer, Precision servo-potentiometer, The Wheatstone Bridge circuit. ○ Applications of temperature like NTC (Negative Temperature Coefficient), Thermistors, RTD Sensor (Platinum Transducer with Temperature dependent Resistance), Temperature sensor IC “Integrated Circuit LM 335”, Type “K” Thermocouples. ○ Applications of light, Photovoltaic Cell. Phototransistor, Photodiode PIN, Photoconductive Cell. ○ Linear position and force like, Linear Variable Differential Transformer LVDT, and Extensiometric Transducer. ○ Environmental measurements like Air flow Sensor, Air pressure Sensor, Humidity sensor. ○ Rotational speed and position control like Slotted optoelectronic Sensor, Optoreflective Sensor, Inductive sensor, Hall effect Sensor, Permanent D.C. magnet tachogenerator. ○ Sound measurements like Dynamical microphone, Ultrasonic receiver. • Visualization Devices like Timing device/ counter with LED display, Graphic bar					

			visualizer and Mobile coil voltmeter. • Output transducers for converting an electrical signal into an analog and evaluation of these transducers, their characteristics, adjustments and practical applications. These include:- o Electrical Resistance o Incandescent Lamp o Applications for the sound output like Buzzing (Buzzer). Mobile coil loud speaker. Ultrasonic transmitter o Applications of linear or angular motion like D.C. Soleinod. D.C. Relay. Solenoid Valve. Permanent Magnet D.C. Motor • Signal Conditioning Circuits for a profound study and analysis of the numerous circuits and included signal conditioners, in addition to the particular of amplifiers, signal converter circuits, comparators, filters and circuits that carry out mathematical operations. These include:- o D.C. and A.C. Amplifiers o Power and Current Amplifier o Buffers o Inverting Amplifier o Differential amplifier o V/F and F/V Converters o V/I and I/V Converters o Full Wave Rectifier o Hysteresis convertible Comparator. o Electronic switch. o Oscillator and Filter 40 kHz. o Time-constant convertible Low Pass Filter. o Circuit with Mathematical Operation for					

			Adding amplifier, Integrator with different time constants, Differentiator with different time constants, Instrumentation Amplifier, Circuit SAMPLE & HOLD, Amplifiers with gain control and offset. • Linearly mounted system of a D.C. motor, tachodynamo, reflective, slotted opto-sensors to detect the absolute and incremental position. **Experimental Capabilities** • Characteristics of the Control System • Characteristics of Display devices • Variable Resistance transducers in angle or linear arrangement • Transducers for Applications of Temperature Measurement • Transducers for Light Measuring Applications • Transducers for Environmental Measurement Applications • Characteristics of the Signal Conditioning Circuits					
8		**Modular System for the Study of Sensors and Instruments**	• Unit to study signal conditioning for many sensors and transducers output signals that must be conditioned. • Circuits consist of differential and instrumentation amplifiers, filters, current to voltage and frequency to voltage converters, etc. • RTD's, thermocouples, strain gauge bridges, etc. • PID controller, industrial controller, DC Dimer to introduce the concepts about process control.	No	EU /USA	3		

			• The test modules may operate independently one of another. • Signal Conditioning Circuits: Amplifiers: • DC amplifiers: - 3 Amplifiers. - Input range: +/- 12 Vdc. - Input Impedance: 100 KΩ or equivalent Adjustable gain approx: 1, 10,100 for the “Amplifier 1“and “Amplifier 2“. – Fixed gain approx: 100 for “x100 Amp”. • AC Amplifier: - Input range: 12 Vac. - Adjustable gain approx: 10, 100,1000. – Bandwidth approx: 10 - 16000Hz. Power Amplifier: - Input range: 12 V max. – Output current approx: 1.5 A max. - Output power: approx. 9W max • Current Amplifier: - Gain: 10,000. - Output current: 1A max. • Buffers: - 2 Buffers. - Input voltage: 12V max. Input impedance: 100 KΩ. • Inverting Amplifier: - Input voltage: 12V max. – Input impedance: 100 KΩ. - Gain: -1. • Differential Amplifier: - Input voltage: 12V max. – Inputs impedance: 100 KΩ (Input A) and 200 KΩ (Input B). Ad (Differential gain): approx. 1.0. - Ac (Common mode gain): 0.02 max. • Instrumentation Amplifier: - Input voltage: 12V max. - Inputs impedance: 100 KΩ. – Ad (Differential gain): 1.0. - Ac (Common mode gain): 0.006 max • Summing Amplifier: - Input voltage: 12V max. - 3 Inputs. - Gain: 1 • Comparators: Schmitt trigger. • Filters: 40kHz filter: Pass-Band Filter at 40kHz. Low-pass filter: Selectable cut-off frequencies at approx15Hz, 1.44Hz, 0.14Hz.					

			• Integrator: Selectable Time constants: 100ms, 1s, 10s • Differentiator: Selectable Time constants: 10ms, 100ms, 1s. • "Sample/Hold": Time constant: 1ms. • Measurement instrumentation (oscilloscope, multimeter, etc • PID: Process control applications. Independent PID parameters adjustment (Proportional, Integrative and Derivative). • Industrial Controller: Input: DC voltage, RTD sensor or Thermocouple. • Dimmer: Light dimmer or DC motor speed controller applications. PWM generator. Frequency and duty cycle adjustable. • Wave Generator: Sine, square, triangular and sawtooth waveforms. • Frequency range: 100 to 10000 Hz. • Amplitude range: Adjustable +/- 10V. Potentiometers: 4 approx • Potentiometers. Impedance values: 0-1 KΩ, 0-5 KΩ, 0-10 KΩ and 0-20 KΩ • Power dissipation: 1 W approx. • Measuring Elements: L.E.D. bar graph display: Input range: 0-5V. • Counter/Timer: Temporization applications. Counting applications. • Moving coil meter **Flow Test Module** • Painted steel box. • Connection diagrams for each transducer should be represented graphically. • Flow switch to monitor the flow and closes an electric circuit.					

			• Contact form: N/O. Switching voltage AC: 240Vac. Switching voltage DC: 120Vdc. • Optical flow sensor to give output in pulses proportional to the liquid flow. • Measurement range: Approx. 0.20 to 7.5 l/min. • K factor: approx. 4600 pulses/liter. • Underwater pump to change the water volume in the test module. • Pressure level sensor to measure the pressure caused by the water in relation to the atmospheric pressure. • Pressure range: approx. 0 to 1psi. • Sensitivity: approx. 15.7mV/psi. • Changeable flow meter to read the • Volume and measure flowing through the pipe. • Range: approx. 0-4 l/min. • V narrowing connection between the main and the secondary tank. **Experimental Capabilities:-** • To measure the water volume produced by an underwater pump in the module using an optical flow sensor. • To use a high-resolution optical flow sensor to measure low flow volumes. • Pressure level sensor. To use a differential pressure sensor to measure the liquid level in one of the tanks **Temperature Test Module** • Bimetallic switch sensor • Opening temperature: approx. 60°C. • Closing temperature: approx. 35°C. • Adjustable bimetallic thermostat to minimize the differential cycles and prevent over peaks. • Temperature range: Approx. 0°C to 40°C.					

			• Magnetic Block: Composed of a ferrite pipe or equivalent. • Relay AC to turn on and off the incandescent lamp placed over the temperature sensors. • Capillary thermostat: Temperature range: approx. 0ºC-100ºC. • Max. bulb temperature: approx. 160ºC. • Thermocouples: Min. 3 thermocouples J or K type • They must be used to measure the temperature that each one of the sensor are controlling. • Temperature range: approx. -40 ºC to 280 ºC. **Experimental Capabilities:-** • To use the Curie effect as application of a high temperature thermostatic controller. • To use the bimetallic thermostat as a temperature controller, calculating its hysteresis. • To use the thermostat based on a bimetallic sensor to control the temperature. **Pressure Test Module** • Painted steel box. • Connection diagrams for each transducer should be represented graphically. • Linear positioning sensor (Potentiometer): Resistor range: Approx. 550 Ω to 4.5KΩ. Operation force: Approx. 220-800g. • LVDT sensor: Sensibility: Approx. 750mV/mm. Power voltage: Approx. 4 to13Vdc. Total path: Approx. 2.5mm. • Differential pressure sensor: Approx. Measurement range: 0 to 30 psi. Sensibility: Approx. 3.33mV/psi. Overpressure: 60 psi.					

			Power supply range: 10 to 16 Vdc. 2 • Strain gauges mounted in a Wheatstone bridge: • Nominal resistor: 25ºC: Approx. 130Ω. • Gauge factor: 2.00 to 2.2 typical. • Nominal resistor tolerance: +/-0.5% • Manometric pressure sensor: • Air Compressor inside the box: Air flow: approx. 12 l./min. • Pressure: approx. 1.90Kg/cm. **Experimental Capabilities:-** • Use of linear positioning sensor (potentiometer) to detect the displacement produced by a diaphragm expansion caused by the air pressure. • Use of a LVDT as an element to measure the diaphragm distortion that is consequence of the pressure inside the pressure chamber. • Differential pressure sensor with hole-board system. Use of a differential pressure sensor of the semiconductor type to measure the pressure fall in a hole-board system. • Measure the pressure in the chamber, using two different types of sensors (manometric and absolute pressure sensor). • To detect objects using an infrared sensor by light beam interruption. • Measurement of deformations: their resistance changes as the diaphragm expands due to the pressure coming from the pressure chamber					
9		**Spring Stiffness Measuring Machine**	• A sturdy metal frame with adjustable feet and a 500 mm metric measuring scale to support spring experiments and to allow for storage of	No	EU /USA	1		

			unused springs and masses • A transparent pointer to allow for accurate extension measurement • Fundamental and accurate test instrument to test single springs and springs in series and parallel • Tests springs and finds their properties • Includes a set of different springs to compare spring rates and effect of different spring sizes. • Set of 21 different springs including Two identical springs for parallel tests and a range of springs with rates of 20 N/m to 140 N/m • Set of masses including set of 10 g masses to give 10 g to 500 g (including the 10 g hanger) and set of 100 g masses to give 100 g to 1 kg (including the 100 g hanger) • Five hooks • Two parallel hanger brackets **Experimental Capabilities:-** • Spring rate and Hooke's law • To prove the basic rules of spring design • A simple spring scale • Springs in series • Springs in parallel					
10		**Impact Testing Machine**	• Bench-top unit with adjustable legs. • Anodized aluminum frame and panels in painted steel • Pendulum mounted in ball bearings and precision balanced and an length of approx. 330mm • Heavy and stable cast iron mounting. Appropriate hammer for Charpy or Izod test • Initial angle: Approx. 140° • Max Impact Energy: Approx16J	No	EU /USA	1		

			• 1 scale Graduation: 0.1 J • Chapry potential energy: Approx. 4J, 7J, 10J • Izod potential energy: Approx 8J. • Allen keys in order to tighten the specimen into clamps • 10 sets of test pieces of three different steel qualities • Protection transparent cover to allow the safe viewing of the experiments by the students. **Experimental Capabilities** • Experimental determination of energy needed to break specimen of different materials using Charpy method • Experimental determination of energy needed to break specimen of different materials using Izod method • Experimental determination of the pendulum's friction losses					
11		**Combustion Test Unit with DAQ system**	• For study of the combustion process • Unit mounted on a metallic frame ensuring safe access to the equipment, burner, combustion chamber and all the accessories and control panels with easy handling • Frame made of anodized aluminum and panels made of painted steel • Castors wheels with brake and frame made of galvanized steel, rubber tyre • Multiple Fuel Burner (Diesel oil, natural gas, LPG, LNG etc) minimum 70 KW capacity • Fuel lines have appropriate filters and safety measures • The natural gas line includes: ○ Manual valve.	No	EU /USA	1		

			○ Gas filter. ○ Pressure sensor, range: 0 - 1 bar. ○ Pressure regulator, range: 0 - 3 bar. ○ Manometer, range: 0 - 400 mbar. ○ Electronic solenoid valve and safety pressure switch. ○ Flow sensor, range: 3 - 21 m3/h. ○ Needle valve to regulate the gas inlet flow. • The fuel oil line includes: ○ Manual valve. ○ Electronic solenoid valve. ○ Flow sensor, range: 4 - 38 kg/h. ○ Needle valve to regulate the liquid fuel inlet flow. • Burner has following systems ○ An integrated fan for providing required air for the combustion ○ A differential pressure sensor to measure the air flow provided, ○ A thermocouple to determine air flow temperature ○ A regulator for controlling the air flow ○ a flame detection sensor and an ignition controller. • Safety features of the burner must include by cutting fuel to the burner:- ○ Excessive outlet water temperature ○ Excessive water pressure inside the cooling jacket ○ Cooling water flow lower than required • Water cooled combustion chamber made of stainless steel (Min size 530 mm outer dia and 920 mm length • Cooling jacket with thermometer, manometer and pressure switch to avoid overpressure in					

			the jacket. • At least two observation points (of 100 mm each) at their sides for observing flame quality • Two Storage and supply tanks for the fuel oil. • Suction pump of the fuel into the burner. • Air ventilation, safety and drain valves. • At least five temperature sensors: combustion chamber, cooling water inlet and outlet, combustion fumes outlet and air inlet to the burner. • Four Flow sensors: natural gas inlet, fuel oil inlet, cooling water flow inlet and air inlet (by means of a differential pressure sensor, range with appropriate range • A pressure sensor: natural gas inlet • Two solenoid valves, one for each working flow: gas or fuel oil • Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software. • SCADA system. • Simultaneous visualization in the computer of all parameters involved in the process. • Real time curves representation about system responses. • All the actuators' values should be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process. • Shield and filtered signals to avoid external interferences. • The Data Acquisition board as part of the SCADA system with PCI Express Data acquisition board (National Instruments) to be					

			placed in a computer slot. • Analog input: Channels= 16 • Sampling rate up to: 250 KS/s (kilo samples per second). • Analog output: Channels=2. • The system has Computer Control +Data Acquisition + Data Management Softwares as part of the SCADA system and are Compatible with the industry standards. • Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters • Sampling velocity up to 250 KS/s (kilo samples per second) • Combustion gases analyzer for measurement of the contents of O_2, CO and CO_2, efficiency of the combustion, air excess and CO/CO_2ratio in exhaust gases. **Experimental Capabilities:-** • Study of the combustion process and the burner operation. • Familiarisation of the adjustment and operation of a fuel oil or gas burner. • Effects of the air / fuel ratio both in the efficiency of the combustion and in the measuring of the combustion gases components and in the temperature. • Study of effects of air / fuel ratio on energy balance. • Study of effects of air / fuel ratio on heat transfer. • Study of effects of flame radiation on heat transfer and observed temperature.					

			• Comparison of flue gas analysis with theoretical predictions. • Comparison of the performance of different fuels • Assessment of a burner, including: ○ Flame stability. ○ Flame shape. ○ Flame radiation. ○ Firing rate. ○ Turndown range. ○ Smoke emission. • Comparison between a gas burner and a fuel oil burner.					
12		**Nozzle Performance Test Unit with DAQ System and Software**	• Equipment is designed to allow students to investigate and study the performance of a nozzle (kinetic energy and thrust). • A floor standing or Bench top unit. • Anodized aluminum structure and panels of painted steel. • Main metallic elements of stainless steel • Demonstration of the thermodynamics of the adiabatic expansion of air through subsonic and supersonic nozzles • Chamber made of stainless steel or equivalent • Chamber Dia: Approx. 220mm • Height: Approx. 420mm • Nozzle Kit containing 4-6 nozzles with minimum five nozzles of 2 mm of nominal throat minimum ○ Convergent Nozzles: Min. 1 nozzle with approx. ratio of 1 ○ Convergent/Divergent Nozzle: 3-4 nozzles with approx. 1.3, 1,.5, 1,7 and 2.1 ratio. • A pressure regulator to maintain the pressure	No	EU /USA	1		

			in the chamber. Range: 0-12bar approx. • Min. 2 pressure sensors to measure the pressure at inlet and outlet • Min 2 temperature sensors “J” or “K” type to measure the temperature inside the chamber • Flow sensors with range of approx. 0-600 l/min to measure the flow rate in the chamber • Adjustable on/off valves to direct the air • Force sensors ranging approx. 4N • Orifice dia: approx. 60mm • System for supply of compressed air for operation of equipment (May be local) • DAQ System for instant recording of multiple readings and automatic calculations • DAQ System must be based upon National Instruments Data Acquisition Board for o Real time curves representation about system responses o Real time PID control for parameters involved in the process o Analog input with 16 channels and Sampling rate up to: 250 KS/s (kilo samples per second) o Analog output with 2 Channels and Maximum output rate up to: 900 KS/s o Digital Input / Output with 24 channels **Experimental Capabilities** • The phenomenon of choked flow corresponding to sonic velocity at a nozzle throat • Determination of jet reaction and specific thrust at a variety of inlet and back pressure. • Determination of inlet pressure effect on mass flow rate, for a given back pressure.					

			• Comparison of actual mass flow rate with the theoretical value. • Determination of the back pressure effect on the mass flow rate. • Nozzle efficiency calculation. • Determination of the jet velocity and the nozzle efficiency. • Determination of the jet reaction and the specific pushing • Measurement of mass flow rate and coefficient of discharge.				

Firm Name: _____

Signature: _____

Name: _____

Designation: _____

Annex A-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: 05°C to +40°C (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 Required (3) Trouble shooting guide (4) Cleaning requirements (b) 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.						

(d) Recorded video lectures of the equipment explaining use / functions / maximum possible experiments.						
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 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). (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 operational/ maintenance training at NUTECH by rep of OEM (local suppliers)						
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) Incase 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: _____

Annex-B

TECHNICAL OFFER

NUTECH / SCM / Mechanical Lab Eqpt (Ph-IV) 2020 / TD-151

Fill in following essential parameters:-

1. Validity of Offer: _____Days (Should not be less than **120 days**)
2. Delivery period: _____Days (After placement of order)
3. Country of Origin: _____
4. Warranty Period: _____

General

1. GST Number: _____ (Enclose Copy)
2. NTN / CNIC: _____ (if exempted, provide valid exemption certificate)

Payment Terms

1. 80 % through LC on sight.
2. 20% after delivery, installation / commissioning, user satisfaction certificate.

Details of Foreign Principal Information with account details)

1. Name / Title: _____
2. Address: _____

OEM Name:	Firm Name:	Signature:
OEM Focal Person:	Firm Focal Person:	Official Seal:
OEM Phone Number:	Firm Phone Number:	Name:
OEM Email Id:	Firm Email Id:	Designation:

Annex C

FINANCIAL OFFER

Ser	Part No	Item Name/Size	Specification	A/U	Qty Req	Price Per Unit (USD)	Total Price (USD)
1		**Stress and strain analysis on a membrane (Diaphragm) with DAQ System and Software**	• Bench-top unit. • Anodized aluminum frame and made of painted steel • Should be able to measure effect of pressure on surface profile of a diaphragm (membrane) • Electrical-resistance precision strain gauges for measuring diaphragm strains • Switch to tare the deformation measurements. • Strain gauges connectors. • Digital display for the deformation measurement. • Self-contained, hand-operated hydraulic pressurizing system for accurate pressure control • Pressure: Displayed by Bourdon gauge • Surface profile measurement provision though digital indicators, • Strain: Measured by electrical resistance gauges and displayed digitally • Cylinder Oil: SL Hydraulic Oil • Diaphragm material: Aluminum alloy to BS6082-T6 or equivalent • Diaphragm nominal thickness: 3.0 mm approximate • Diaphragm Dimensions; • Nominal diameter = 200 mm approximate or higher • Nominal thickness = 3 mm approximate • Young's Modulus 69 GN/m^2 or higher • Poisson's Ratio 0.33 approximate or better • Maximum Pressure: 75 kN./m^2 approximate	No	1		

			• At least 2x Circumferential gauges, 2x Radial gauges out of these 1x at 45
			• Approximate no of Strain Gauges: 8
			• Gauge factor: 2 ±0.5% Minimum
			• Dial gauge range 0-25 mm or better
			• Manometer 0-1 bar or better
			• DAQ for recording experimental data and for measuring and displaying
			• DAQ System must operate on LabVIEW software and must have
			  ○ Computer connection : USB 2.0 or better including lead and connectors like shielded twisted pair cables, and other essential accessories for connecting system to Computer
			  ○ Sample rate 20 kHz with 12 bit resolution or higher
			  ○ Bandwidth/Filter cut-off 3 kHz (nominal)
			  ○ Data Export to XLSX and HTML files
			Experimental Capabilities:-
			• Measure radial and tangential strain using strain gauges.
			• Measure deflection using a dial gauge.
			• Calculate the stresses from the measured strains: radial stress, tangential stress.
			• Determine direction of principal stress.
			• Application of Mohr's strain circle to determine the principal strains.
			• Measure circumferential and radial strains of a diaphragm under pressure				

2.		**Heat Exchanger Base Service**	• Common unit for various modules as mentioned in the list. • For heating, pumping the water and controlling the	No	1		

		Unit Apparatus with DAQ System, Software and following modules	direction of water flows and for measuring temperature, and flow rates of Cold and hot water • Covered Stainless steel tank (Min capacity 30 L), with Electric heating element (approximately 3000 W), thermostat for heating water, ("J" type Temperature sensor, mechanism to control the water level, drain valve • Variable speed Centrifugal pump with range 0 – 3 l/min or more. • Flow sensors for hot and cold water, range: 0.25 – 5 l/min or higher. • Control valves for the cold and hot water. • Four ball valves for controlling co-current or counter-current flux in the exchanger. • Two ball valves to control and drain the hot water of the base unit. • Maximum pressure in exchangers 0.6 bar with regulator • Flexible tubes to connect with the different exchangers. • DAQ System must be based upon National Instruments Data Acquisition Board for o Real time curves representation about system responses o Real time PID control for parameters involved in the process o Analog input with 16 channels and Sampling rate up to: 250 KS/s (kilo samples per second) o Analog output with 2 Channels and Maximum output rate up to: 900 KS/s o Digital Input / Output with 24 channels • The equipment and related software must be compatible with heat exchanger modules of Edibon Spain available at the lab and all modules demanded				

			below (2a to 2d) o Extended Concentric Tube Heat Exchanger o Extended Plate Heat Exchanger o Shell and Tube Heat Exchanger				
	2a	**Cross Flow Heat Exchanger with DAQ System and Software**	• Compatible with Item S No 2 • Robust, bench-mounting product • Anodized aluminum frame and panels made of painted steel. • Main metallic elements made of stainless steel. • Rectangular duct of approximate 800 x 200 x 200 mm • Radiator located across the air duct • Heat transfer area of radiator not less than 30000 mm². • Axial fan with maximum air velocity of 4 m/s. • Four “J” or “K” type temperature sensors to measure input and output water and air temperatures. • Velocity sensor to measure air velocity, range: 0 – 5 m/s. • Heating Element Power: Min 100W • PID Computer Control, Data Acquisition and Data Management Software • Softwares as part of the SCADA system and compatible with actual Windows operating systems. • Graphic and intuitive simulation of the process in screen. • Compatible with the industry standards. • Registration and visualization of all process variables in an automatic and simultaneous way • Sampling velocity up to 250 KS/s (kilo samples per second). • Calibration system for the sensors involved in the process.	No	1		

			Experimental Capabilities:- • Introduction to the concept of psychometric properties. • Effect of temperature differential on the heat transfer coefficient. • Overall energy balance in the heat exchanger and study of losses. • Determination of the exchanger effectiveness (NTU method). • Calculating the inlet and mean velocity • Influence of air and water flow on the heat transfer. • Reynolds number calculation.				
	2b	**Jacketed Vessel Heat Exchanger with DAQ System and Software**	• Compatible with Item S No 2 • Unit to study heat transfer between hot water flowing through a jacket and cold water contained in a vessel • Anodized aluminum frame and panels made of stainless steel • Heating of constant mass of water in vessel • Measurement of temperature at inlet and outlet of the exchanger in cold and hot water • Baseplate with clear schematic of experiment • Connection to service module with quick connector • Vessel total volume: Approx. 15L • Interior vessel volume: Approx. 7.5L • Jacket volume: Approx. 7.5L • 4-7 Temperature sensors “J” type or ”K” type • 2-3 sensors for measuring cold water temperature • 3-4 sensors for measuring hot water temperature • PID Computer Control, Data Acquisition and Data	No	1		

			Management Software • Softwares as part of the SCADA system and compatible with actual Windows operating systems. • Graphic and intuitive simulation of the process in screen. • Compatible with the industry standards. • Registration and visualization of all process variables in an automatic and simultaneous way • Sampling velocity up to 250 KS/s (kilo samples per second). • Calibration system for the sensors involved in the process. **Experimental Capabilities:-** • Determination of the exchanger effectiveness NTU method • Influence of the flow on the heat transfer • Calculation of the Reynolds Number • Influence of the vessel stirring on the heat transfer when operating in batches • Influence of vessel's water volume on the heat transfer when operating in batches • Study of pressure drop in the exchanger • Global balance of energy in the heat exchanger and losses study.				
	2c	**Coil Vessel Heat Exchanger with DAQ System and Software**	• Compatible with Item S No 2 • Unit to study heat transfer between hot water flowing through a coil and cold water contained in a vessel • Anodized aluminum frame and panels made of stainless steel • Heating of constant mass of water in vessel	No	1		

			• Measurement of temperature at inlet and outlet of the exchanger in cold and hot water • Baseplate with clear schematic of experiment • Connection to service module with quick connector • Overflow or PVC glass tube • Coil: Copper or stainless steel • Length of coil: Approx. 2m • Inside Dia: Approx. 4mm • Outside Dia: Approx. 6mm • Electric stirrer • 4-7 Temperature sensors “J” type or ”K” type • 2-3 sensors for measuring cold water temperature • 3-4 sensors for measuring hot water temperature • PID Computer Control, Data Acquisition and Data Management Software • Softwares as part of the SCADA system and compatible with actual Windows operating systems. • Graphic and intuitive simulation of the process in screen. • Compatible with the industry standards. • Registration and visualization of all process variables in an automatic and simultaneous way • Sampling velocity up to 250 KS/s (kilo samples per second). • Calibration system for the sensors involved in the process. **Experimental Capabilities:-** • Global balance of energy in the coil heat exchanger with coil and losses study • Determination of the exchanger effectiveness NTU				

			method • Influence of the flow on the heat transfer • Calculation of the Reynolds Number • Influence of the vessel stirring on the heat transfer when operating in batches • Study of pressure drop in the exchanger				
	2d	**Turbulent Heat Exchanger with DAQ system and Software**	• Compatible with Item S No 2 • Unit to study the heat transfer between hot water and cold water. • Hot water circulates through an internal tube • Cold water flows through the annular zone between the internal and the external tube. • Exchanger should operate with co-counter and counter current flows • Anodized aluminum frame and panels made of painted steel. • Main metallic elements made of stainless steel • Three to four segmented baffles • Exchanger should measure cold water and hot water temperatures at different points of the exchanger • Diagram in the front panel with distribution of • the elements • Outer tube Length: 500mm approx. • Internal Dia: 60 mm approx. • External Dia: 50mm approx. • Internal tubes made of stainless steel or copper • Internal tube bundles: min 4 bundles of tubes having L: 500mm approx. • Internal Dia: 4-6 mm approx. • External Dia: 6-10 mm approx. • Internal heat transfer area, Ah= 0.0377 m^2 approx.	No	1		

			• External heat transfer area Ac= 0.0471 m^2 approx. • Min 6 “J” or “K” type temperature sensors • PID Computer Control, Data Acquisition and Data Management Software • Softwares as part of the SCADA system and compatible with actual Windows operating systems. • Graphic and intuitive simulation of the process in screen. • Compatible with the industry standards. • Registration and visualization of all process variables in an automatic and simultaneous way • Sampling velocity up to 250 KS/s (kilo samples per second). • Calibration system for the sensors involved in the process. **Experimental Capabilities:-** • Global energy balance in the heat exchanger and the study of losses. • Exchanger effectiveness determination. NTU Method. • Study of the heat transfer under counter-current and co-current flow conditions. • Flow influence on the heat transfer. • Reynolds number calculation • Obtaining of the correlation that relates Nusselt number with Reynolds number and Prandtl number. • Obtaining of the heat transfer coefficients by convection				
3		**Marcet Boiler with DAQ System and Software**	• A compact, bench top unit for observing pressure and temperature relationship for saturated steam • Anodized aluminum frame with panels made of painted steel	No	1		

			• Stainless Steel vessel (boiler) with observation window
			• The corrosion-resistant high grade stainless steel boiler must comply with the latest European safety standards
			• Metallic elements made of stainless steel
			• Filling cap, Drain Valves and safety key
			• Unit be protected by transparent sheet to allow handling of valves
			• Experiment Pressure range: Approximate 10-15 bar (absolute)
			• Approximate Maximum Pressure 12.5 bar absolute (11.5 bar gauge) controlled through Relief Valve
			• Boiler Volume: Minimum 1.7 liters
			• Heater Power : Min 1 kW
			• Maximum Experiment Temperature: Approx 170º
			• Electric Heater Thermal Cutout: Approx185ºC or higher
			• DAQ System must have
			  ○ Computer connection : USB 2.0 or better including lead and connectors like shielded twisted pair cables, and other essential accessories for connecting system to Computer
			  ○ Bandwidth/Filter cut-off 3 kHz (nominal)
			  ○ Data Export to XLSX and HTML files
			• Electronic sensors measure boiler temperature and pressure - shown on a digital display in both SI and traditional units (including absolute values)
			• Electric Heater with thermostat to limit the maximum heater temperature.
			• Safety features like temperature cut-out switches and a pressure relief valve with appropriate range
			• Electronic sensors for measuring boiler temperature and pressure (absolute and gauge)				

			• A mechanical Bourdon type gauge to independently display the pressure even in case of electricity failure **Experimental Capabilities:-** • Variation of saturated steam pressure with temperature • Confirmation of the Antoine Equation • Comparison of the obtained saturation curves with the theoretical values. • Experimental determination of Clausius-Clapeyron equation for saturated steam and its comparison with theoretical results • Determination of the error percentage between experimental and theoretical (dT/dP) for saturated steam				
4		**Creep Testing Machine with DAQ System and Software**	• A self-contained bench mounting machine for demonstration of phenomenon of creep under different conditions and in different materials • Bench top unit with adjustable legs • Anodized aluminum structure and panels in painted steel • A long lever arm and a bearing as a pivot point • Lever mechanical advantage not less than 8:1 • Dial indicator for measuring elongation of the specimen • Enclosure for surrounding the specimen area to maintain a constant temperature • Typical test times for lead specimens to be from approx. 4 minutes to >18 hours at around 20°C • Thermocouple to measure the temperature effects of creep • Thermometer range -10°C to 50°C • A cool pack to reduce specimen temperature • DAQ system: Displacement sensor, computer interface unit and software to monitor the displacement up to	No	1		

			failure by computer
			• Must operate on LabVIEW software and must have
			  ○ Computer connection : USB 2.0 or better including lead and connectors like shielded twisted pair cables, and other essential accessories for connecting system to Computer
			  ○ Sample rate 20 kHz with 12 bit resolution or higher
			  ○ Bandwidth/Filter cut-off 3 kHz (nominal)
			  ○ Data Export to XLSX and HTML files
			• Following models / specimens or their equivalent in minimum quantity 40 each must be supplied with the machine
			  ○ Lead Creep Specimen with Strain hardening coefficient n = 10, Activation energy for creep Q = 120 kJ/mol
			  ○ Polypropylene Creep Specimen with Young's modulus = 1250 N/mm^2 and Time Exponent k = 0.1 to 0.2
			  ○ Nylon 66 Creep Specimen
			  ○ Unplasticised PVC Creep Specimen
			• Weights and weight hangers
			  ○ 1x 100 g weight
			  ○ 2x 200 g weights
			  ○ 3x 500 g weights
			Experimental Capabilities:-
			• Demonstration of three phases of creep
			• Demonstration of effect temperature on creep
			• The normal breaking load of a specimen over a fixed time
			• Relationship between breaking load and time for lead specimens
			• Time extension curves to show the three phases of				

			creep (primary, secondary and tertiary) • The effect of temperature on the creep rate of specimens				
5		**Fatigue in Rotating Bending Study Unit with DAQ system**	• Bench top unit • Anodized aluminum frame and panels made of painted steel • Four adjustable feet dampers • Transparent cover • Metallic electrical box • Control panel in front having o Disconnector, o main circuit breaker, o differential, emergency stop, o general start-stop with light indicator, o on/off motor, o LED motor condition and general electrical supply o Digital display of the number of cycles before rupture / reset by button • LCD display of the number of cycles before rupture / reset by button with frontage • Three phase asynchronous motor 2850 rev/min or higher. • Shaft guided by ball bearings • A conical clamping chuck for immobilization of test tube • Inductive detector for counting the number of test cycles • Device for application of the force: o Thumbwheel for adjusting the force exerted of the test tube extremity up to 35 kg o Dynamometer for measuring the effort o Mechanical detector of test tube for automatic stopping of counting the number of cycles • Maximum stress: Approximately 350 MPa	No	1		

			• Maximum cycle count: 9.99 x 108 with a one cycle resolution
			• DAQ System for capturing the data to be shown on computer interface
			• Force applied should be varied between 0 -200N
			• Specimens with compatible length and different diameters to be Included like:
			  ○ Min. 40 RF1010 (steel) or equivalent
			  ○ Min. 40 RF1020 (aluminum) or equivalent
			  ○ Min. 40 RF1030 (brass) or equivalent
			• Few samples should have different notches
			• The unit includes all the safety measures required for a safe operation:
			  ○ Metallic protective cages, a fixed one for the motor axis outlet and a removable one for the test piece zone;
			  ○ The unit should not work without these covers to avoid accidents.
			  ○ Automatic shut down in case of the test piece breakage.
			
			Experimental Capabilities:-
			• Identification of parameters inducing the rupture by fatigue
			• Determination of the basic principles of fatigue strength testing
			• Influence of the material on fatigue strength
			• Curve plotting S-N Wohler
			• Statistical approach for measurement of the fatigue
			• Counting the number of cycles at the rupture.
			• Calculating the number of test cycles
			• Influence of the section on fatigue strength				

			• Influence of different curvature radii and surface finish on fatigue • Influence of the notches and surface finish on fatigue strength				
6		**Conductivity of Liquid and Gases**	• Unit to determine thermal conductivity of liquids and gases • Anodized aluminum frame and panels made of painted steel • Cylinder with brass jacket containing the test fluid and refrigeration water • Variable heating element in the cylinder • Heating element with min power of 100W controlled by computer • Digital display of heating power • Min 6High precision Temperature sensors “K” or “T” type thermocouples • Cylinder length: Appox 0.1m • Flow sensor to measure the cooling water flow range: 0.1 to 8 l/min. • Water flow regulation valve • Baseplate with clear schematic of experiment layout • On/Off button • Potentiometer • Compatible with following liquids and gases: • Dry Air • Castor Oil • Carbon Dioxide (CO_2) • Softwares as part of the SCADA system and compatible with actual Windows operating systems. • Graphic and intuitive simulation of the process in screen. • Compatible with the industry standards.	No	1		

			• Registration and visualization of all process variables in an automatic and simultaneous way • Sampling velocity up to 250 KS/s (kilo samples per second). • Calibration system for the sensors involved in the process. • The equipment and related software must be compatible with Heat Transfer Base Unit of Edibon Spain available at the lab **Experimental Capabilities:-** • Determination of thermal conductivity of different liquids and gases • Obtaining of the curve of thermal conductivity of the air. • Determination of Thermal conductivity in vacuum • Water thermal conductivity determination • Thermal conductivity determination of a mineral oil • Calibration of Unit • Thermal conductivity of dry air				
7		**Transducers Trainer**	• The Trainer shows most of the devices used in the industry that allow the electronic systems to communicate with the real world, to measure physical variables and to control industrial processes. • Input Transducers for converting analog signal into an electrical one and evaluation of these transducers, with their characteristics, adjustments and practical applications can be made. These include:- ○ Resistance Transducers for applications in angular or linear position like Linearly sliding potentiometer, Rotary carbon-track potentiometer, Rotary coil potentiometer, Precision servo-potentiometer, The Wheatstone Bridge circuit.	No	3		

			○ Applications of temperature like NTC (Negative Temperature Coefficient), Thermistors, RTD Sensor (Platinum Transducer with Temperature dependent Resistance), Temperature sensor IC "Integrated Circuit LM 335", Type "K" Thermocouples. ○ Applications of light, Photovoltaic Cell. Phototransistor, Photodiode PIN, Photoconductive Cell. ○ Linear position and force like, Linear Variable Differential Transformer LVDT, and Extensiometric Transducer. ○ Environmental measurements like Air flow Sensor, Air pressure Sensor, Humidity sensor. ○ Rotational speed and position control like Slotted optoelectronic Sensor, Optoreflective Sensor, Inductive sensor, Hall effect Sensor, Permanent D.C. magnet tachogenerator. ○ Sound measurements like Dynamical microphone, Ultrasonic receiver. • Visualization Devices like Timing device/ counter with LED display, Graphic bar visualizer and Mobile coil voltmeter. • Output transducers for converting an electrical signal into an analog and evaluation of these transducers, their characteristics, adjustments and practical applications. These include:- ○ Electrical Resistance ○ Incandescent Lamp ○ Applications for the sound output like Buzzing (Buzzer). Mobile coil loud speaker. Ultrasonic transmitter ○ Applications of linear or angular motion like D.C.				

			Soleinod. D.C. Relay. Solenoid Valve. Permanent Magnet D.C. Motor • Signal Conditioning Circuits for a profound study and analysis of the numerous circuits and included signal conditioners, in addition to the particular of amplifiers, signal converter circuits, comparators, filters and circuits that carry out mathematical operations. These include:- ○ D.C. and A.C. Amplifiers ○ Power and Current Amplifier ○ Buffers ○ Inverting Amplifier ○ Differential amplifier ○ V/F and F/V Converters ○ V/I and I/V Converters ○ Full Wave Rectifier ○ Hysteresis convertible Comparator. ○ Electronic switch. ○ Oscillator and Filter 40 kHz. ○ Time-constant convertible Low Pass Filter. ○ Circuit with Mathematical Operation for Adding amplifier, Integrator with different time constants, Differentiator with different time constants, Instrumentation Amplifier, Circuit SAMPLE & HOLD, Amplifiers with gain control and offset. • Linearly mounted system of a D.C. motor, tachodynamo, reflective, slotted opto-sensors to detect the absolute and incremental position. **Experimental Capabilities** • Characteristics of the Control System • Characteristics of Display devices • Variable Resistance transducers in angle or linear arrangement				

			• Transducers for Applications of Temperature Measurement • Transducers for Light Measuring Applications • Transducers for Environmental Measurement Applications • Characteristics of the Signal Conditioning Circuits				
8		**Modular System for the Study of Sensors and Instruments**	• Unit to study signal conditioning for many sensors and transducers output signals that must be conditioned. • Circuits consist of differential and instrumentation amplifiers, filters, current to voltage and frequency to voltage converters, etc. • RTD's, thermocouples, strain gauge bridges, etc. • PID controller, industrial controller, DC Dimer to introduce the concepts about process control. • The test modules may operate independently one of another. • Signal Conditioning Circuits: Amplifiers: • DC amplifiers: - 3 Amplifiers. - Input range: +/-12 Vdc. - Input Impedance: 100 KΩ or equivalent Adjustable gain approx: 1, 10,100 for the “Amplifier 1“and “Amplifier 2“. – Fixed gain approx: 100 for “x100 Amp”. • AC Amplifier: - Input range: 12 Vac. - Adjustable gain approx: 10, 100,1000. – Bandwidth approx: 10 - 16000Hz. Power Amplifier: - Input range: 12 V max. – Output current approx: 1.5 A max. - Output power: approx. 9W max • Current Amplifier: - Gain: 10,000. - Output current: 1A max. • Buffers: - 2 Buffers. - Input voltage: 12V max. Input impedance: 100 KΩ. • Inverting Amplifier: - Input voltage: 12V max. – Input impedance: 100 KΩ. - Gain: -1.	No	3		

			• Differential Amplifier: - Input voltage: 12V max. – Inputs impedance: 100 KΩ (Input A) and 200 KΩ (Input B). Ad (Differential gain): approx. 1.0. - Ac (Common mode gain): 0.02 max. • Instrumentation Amplifier: - Input voltage: 12V max. - Inputs impedance: 100 KΩ. – Ad (Differential gain): 1.0. - Ac (Common mode gain): 0.006 max • Summing Amplifier: - Input voltage: 12V max. - 3 Inputs. - Gain: 1 • Comparators: Schmitt trigger. • Filters: 40kHz filter: Pass-Band Filter at 40kHz. Low-pass filter: Selectable cut-off frequencies at approx15Hz, 1.44Hz, 0.14Hz. • Integrator: Selectable Time constants: 100ms, 1s, 10s • Differentiator: Selectable Time constants: 10ms, 100ms, 1s. • “Sample/Hold”: Time constant: 1ms. • Measurement instrumentation (oscilloscope, multimeter, etc • PID: Process control applications. Independent PID parameters adjustment (Proportional, Integrative and Derivative). • Industrial Controller: Input: DC voltage, RTD sensor or Thermocouple. • Dimmer: Light dimmer or DC motor speed controller applications. PWM generator. Frequency and duty cycle adjustable. • Wave Generator: Sine, square, triangular and sawtooth waveforms. • Frequency range: 100 to 10000 Hz. • Amplitude range: Adjustable +/- 10V. Potentiometers: 4 approx				

			• Potentiometers. Impedance values: 0-1 KΩ, 0-5 KΩ, 0-10 KΩ and 0-20 KΩ • Power dissipation: 1 W approx. • Measuring Elements: L.E.D. bar graph display: Input range: 0-5V. • Counter/Timer: Temporization applications. Counting applications. • Moving coil meter **Flow Test Module** • Painted steel box. • Connection diagrams for each transducer should be represented graphically. • Flow switch to monitor the flow and closes an electric circuit. • Contact form: N/O. Switching voltage AC: 240Vac. Switching voltage DC: 120Vdc. • Optical flow sensor to give output in pulses proportional to the liquid flow. • Measurement range: Approx. 0.20 to 7.5 l/min. • K factor: approx. 4600 pulses/liter. • Underwater pump to change the water volume in the test module. • Pressure level sensor to measure the pressure caused by the water in relation to the atmospheric pressure. • Pressure range: approx. 0 to 1psi. • Sensitivity: approx. 15.7mV/psi. • Changeable flow meter to read the • Volume and measure flowing through the pipe. • Range: approx. 0-4 l/min. • V narrowing connection between the main and the secondary tank. **Experimental Capabilities:-**				

			• To measure the water volume produced by an underwater pump in the module using an optical flow sensor. • To use a high-resolution optical flow sensor to measure low flow volumes. • Pressure level sensor. To use a differential pressure sensor to measure the liquid level in one of the tanks **Temperature Test Module** • Bimetallic switch sensor • Opening temperature: approx. 60°C. • Closing temperature: approx. 35°C. • Adjustable bimetallic thermostat to minimize the differential cycles and prevent over peaks. • Temperature range: Approx. 0°C to 40°C. • Magnetic Block: Composed of a ferrite pipe or equivalent. • Relay AC to turn on and off the incandescent lamp placed over the temperature sensors. • Capillary thermostat: Temperature range: approx. 0ºC-100ºC. • Max. bulb temperature: approx. 160ºC. • Thermocouples: Min. 3 thermocouples J or K type • They must be used to measure the temperature that each one of the sensor are controlling. • Temperature range: approx. -40 ºC to 280 ºC. **Experimental Capabilities:-** • To use the Curie effect as application of a high temperature thermostatic controller. • To use the bimetallic thermostat as a temperature controller, calculating its hysteresis. • To use the thermostat based on a bimetallic sensor to control the temperature.				

			Pressure Test Module • Painted steel box. • Connection diagrams for each transducer should be represented graphically. • Linear positioning sensor (Potentiometer): Resistor range: Approx. 550 Ω to 4.5KΩ. Operation force: Approx. 220-800g. • LVDT sensor: Sensibility: Approx. 750mV/mm. Power voltage: Approx. 4 to13Vdc. Total path: Approx. 2.5mm. • Differential pressure sensor: Approx. Measurement range: 0 to 30 psi. Sensibility: Approx. 3.33mV/psi. Overpressure: 60 psi. Power supply range: 10 to 16 Vdc. 2 • Strain gauges mounted in a Wheatstone bridge: • Nominal resistor: 25ºC: Approx. 130Ω. • Gauge factor: 2.00 to 2.2 typical. • Nominal resistor tolerance: +/-0.5% • Manometric pressure sensor: • Air Compressor inside the box: Air flow: approx. 12 l./min. • Pressure: approx. 1.90Kg/cm. **Experimental Capabilities:-** • Use of linear positioning sensor (potentiometer) to detect the displacement produced by a diaphragm expansion caused by the air pressure. • Use of a LVDT as an element to measure the diaphragm distortion that is consequence of the pressure inside the pressure chamber. • Differential pressure sensor with hole-board system. Use of a differential pressure sensor of the semiconductor type to measure the pressure fall in a				

			hole-board system. • Measure the pressure in the chamber, using two different types of sensors (manometric and absolute pressure sensor). • To detect objects using an infrared sensor by light beam interruption. • Measurement of deformations: their resistance changes as the diaphragm expands due to the pressure coming from the pressure chamber				
9		**Spring Stiffness Measuring Machine**	• A sturdy metal frame with adjustable feet and a 500 mm metric measuring scale to support spring experiments and to allow for storage of unused springs and masses • A transparent pointer to allow for accurate extension measurement • Fundamental and accurate test instrument to test single springs and springs in series and parallel • Tests springs and finds their properties • Includes a set of different springs to compare spring rates and effect of different spring sizes. • Set of 21 different springs including Two identical springs for parallel tests and a range of springs with rates of 20 N/m to 140 N/m • Set of masses including set of 10 g masses to give 10 g to 500 g (including the 10 g hanger) and set of 100 g masses to give 100 g to 1 kg (including the 100 g hanger) • Five hooks • Two parallel hanger brackets **Experimental Capabilities:-** • Spring rate and Hooke's law • To prove the basic rules of spring design • A simple spring scale	No	1		

			• Springs in series • Springs in parallel				
10		**Impact Testing Machine**	• Bench-top unit with adjustable legs. • Anodized aluminum frame and panels in painted steel • Pendulum mounted in ball bearings and precision balanced and an length of approx. 330mm • Heavy and stable cast iron mounting. Appropriate hammer for Charpy or Izod test • Initial angle: Approx. 140° • Max Impact Energy: Approx16J • 1 scale Graduation: 0.1 J • Chapry potential energy: Approx. 4J, 7J, 10J • Izod potential energy: Approx 8J. • Allen keys in order to tighten the specimen into clamps • 10 sets of test pieces of three different steel qualities • Protection transparent cover to allow the safe viewing of the experiments by the students. **Experimental Capabilities** • Experimental determination of energy needed to break specimen of different materials using Charpy method • Experimental determination of energy needed to break specimen of different materials using Izod method • Experimental determination of the pendulum's friction losses	No	1		
11		**Combustion Test Unit with DAQ system**	• For study of the combustion process • Unit mounted on a metallic frame ensuring safe access to the equipment, burner, combustion chamber and all the accessories and control panels with easy handling • Frame made of anodized aluminum and panels made of painted steel	No	1		

			• Castors wheels with brake and frame made of galvanized steel, rubber tyre • Multiple Fuel Burner (Diesel oil, natural gas, LPG, LNG etc) minimum 70 KW capacity • Fuel lines have appropriate filters and safety measures • The natural gas line includes: o Manual valve. o Gas filter. o Pressure sensor, range: 0 - 1 bar. o Pressure regulator, range: 0 - 3 bar. o Manometer, range: 0 - 400 mbar. o Electronic solenoid valve and safety pressure switch. o Flow sensor, range: 3 - 21 m3/h. o Needle valve to regulate the gas inlet flow. • The fuel oil line includes: o Manual valve. o Electronic solenoid valve. o Flow sensor, range: 4 - 38 kg/h. o Needle valve to regulate the liquid fuel inlet flow. • Burner has following systems o An integrated fan for providing required air for the combustion o A differential pressure sensor to measure the air flow provided, o A thermocouple to determine air flow temperature o A regulator for controlling the air flow o a flame detection sensor and an ignition controller. • Safety features of the burner must include by cutting fuel to the burner:- o Excessive outlet water temperature o Excessive water pressure inside the cooling jacket o Cooling water flow lower than required				

			• Water cooled combustion chamber made of stainless steel (Min size 530 mm outer dia and 920 mm length • Cooling jacket with thermometer, manometer and pressure switch to avoid overpressure in the jacket. • At least two observation points (of 100 mm each) at their sides for observing flame quality • Two Storage and supply tanks for the fuel oil. • Suction pump of the fuel into the burner. • Air ventilation, safety and drain valves. • At least five temperature sensors: combustion chamber, cooling water inlet and outlet, combustion fumes outlet and air inlet to the burner. • Four Flow sensors: natural gas inlet, fuel oil inlet, cooling water flow inlet and air inlet (by means of a differential pressure sensor, range with appropriate range • A pressure sensor: natural gas inlet • Two solenoid valves, one for each working flow: gas or fuel oil • Three safety levels, one mechanical in the unit, another electronic in the control interface and the third one in the control software. • SCADA system. • Simultaneous visualization in the computer of all parameters involved in the process. • Real time curves representation about system responses. • All the actuators' values should be changed at any time from the keyboard allowing the analysis about curves and responses of the whole process. • Shield and filtered signals to avoid external interferences.				

			• The Data Acquisition board as part of the SCADA system with PCI Express Data acquisition board (National Instruments) to be placed in a computer slot. • Analog input: Channels= 16 • Sampling rate up to: 250 KS/s (kilo samples per second). • Analog output: Channels=2. • The system has Computer Control +Data Acquisition + Data Management Softwares as part of the SCADA system and are Compatible with the industry standards. • Flexible, open and multicontrol software, developed with actual windows graphic systems, acting simultaneously on all process parameters • Sampling velocity up to 250 KS/s (kilo samples per second) • Combustion gases analyzer for measurement of the contents of O_2, CO and CO_2, efficiency of the combustion, air excess and CO/CO_2ratio in exhaust gases. **Experimental Capabilities:-** • Study of the combustion process and the burner operation. • Familiarisation of the adjustment and operation of a fuel oil or gas burner. • Effects of the air / fuel ratio both in the efficiency of the combustion and in the measuring of the combustion gases components and in the temperature. • Study of effects of air / fuel ratio on energy balance. • Study of effects of air / fuel ratio on heat transfer. • Study of effects of flame radiation on heat transfer and observed temperature. • Comparison of flue gas analysis with theoretical				

			predictions. • Comparison of the performance of different fuels • Assessment of a burner, including: o Flame stability. o Flame shape. o Flame radiation. o Firing rate. o Turndown range. o Smoke emission. • Comparison between a gas burner and a fuel oil burner.				
12		**Nozzle Performance Test Unit with DAQ System and Software**	• Equipment is designed to allow students to investigate and study the performance of a nozzle (kinetic energy and thrust). • A floor standing or Bench top unit. • Anodized aluminum structure and panels of painted steel. • Main metallic elements of stainless steel • Demonstration of the thermodynamics of the adiabatic expansion of air through subsonic and supersonic nozzles • Chamber made of stainless steel or equivalent • Chamber Dia: Approx. 220mm • Height: Approx. 420mm • Nozzle Kit containing 4-6 nozzles with minimum five nozzles of 2 mm of nominal throat minimum o Convergent Nozzles: Min. 1 nozzle with approx. ratio of 1 o Convergent/Divergent Nozzle: 3-4 nozzles with approx. 1.3, 1,.5, 1,7 and 2.1 ratio. • A pressure regulator to maintain the pressure in the chamber. Range: 0-12bar approx.	No	1		

			• Min. 2 pressure sensors to measure the pressure at inlet and outlet • Min 2 temperature sensors “J” or “K” type to measure the temperature inside the chamber • Flow sensors with range of approx. 0-600 l/min to measure the flow rate in the chamber • Adjustable on/off valves to direct the air • Force sensors ranging approx. 4N • Orifice dia: approx. 60mm • System for supply of compressed air for operation of equipment (May be local) • DAQ System for instant recording of multiple readings and automatic calculations • DAQ System must be based upon National Instruments Data Acquisition Board for o Real time curves representation about system responses o Real time PID control for parameters involved in the process o Analog input with 16 channels and Sampling rate up to: 250 KS/s (kilo samples per second) o Analog output with 2 Channels and Maximum output rate up to: 900 KS/s o Digital Input / Output with 24 channels **Experimental Capabilities** • The phenomenon of choked flow corresponding to sonic velocity at a nozzle throat • Determination of jet reaction and specific thrust at a variety of inlet and back pressure. • Determination of inlet pressure effect on mass flow rate, for a given back pressure. • Comparison of actual mass flow rate with the theoretical				

			value. • Determination of the back pressure effect on the mass flow rate. • Nozzle efficiency calculation. • Determination of the jet velocity and the nozzle efficiency. • Determination of the jet reaction and the specific pushing • Measurement of mass flow rate and coefficient of discharge.				
Total Amount							

Firm Name: _____

Signature: _____

Name: _____

Designation: _____

Tender No_____

Name of the Firm _____

Firm Address_____

Date_____

Telephone No_____

E-Mail_____

To,

DD SCM Office
NUTECH University
I-12, Main IJP Road,
Islamabad.

Dear Sir

1. I / We hereby offer to supply to the NUTECH University the stores detailed in schedule to the tender inquiry or such portion thereof as you may specify in the acceptance of tender at the price offered against the said schedule and further agree that this offer will remain valid up to 90 days after opening of Financial offer and will not be withdrawn or altered in terms of rates quoted and the conditions already stated therein or on before this date. I / we shall be bound by a communication of acceptance to be dispatched within he prescribed time.

2. I / we have understood the instructions to Tenders and General Conditions Governing Contract available at NUTECH website and have thoroughly examined the specifications / drawing and / or patterns quoted in the schedule here to and am/are fully aware of the nature of the stores required and my/ our offer is to supply stores strictly in accordance with the requirements.

Yours Faithfully.

(Signature of Tenderer)
Designation
Date:

Individual signing tender and / or other documents connected with a contract must be signed by principal authorized rep/ OEM rep/ Authorized partner firm rep.

SPECIMEN FOR "ADVANCE PAYMENT BANK GUARANTEE"

Guarantee No: _____Date_____ Amount:_____ Valid upto:_____

In Favour of:

National University of Technology (NUTECH), IJP Road, I-12, Islamabad

Subject: **Advance Payment Bank Guarantee**

Contract No: _____DATED._____

Dear Sir,

1. We [Name of Guarantor] understand that you have entered into contract with M/S [Name of Firm] (hereinafter called Our Client), for provision of [Name of Stores]. And as per the above mentioned Contract, you are liable to pay to Our Client an amount of [Amount of Guarantee] in advance, which shall be released against a Bank Guarantee.

2. Bank & seller firm shall inform your office regarding termination of the validity of this bank Guarantee one clear month before the actual expiry date of this Bank Guarantee.

3. Now, we hereby irrevocably undertake to immediately make payment on to your orders, merely upon receipt of your first written notice, an amount not exceeding [Amount of Guarantee] that may be claimed by you at your own discretion without it being necessary for you to prove or even assert to the Bank any default whatsoever of Our Client under the Contract.

4. Claims against this Guarantee shall be lodged on us through written request/s on your proper Letter Head. Unless claims are not presented on or before the Validity Date, all rights and benefits under this guarantee shall be forfeited and we shall be released from all claims, demands or liabilities of any kind whatsoever.

5. This Guarantee shall remain in force up to the above mentioned Validity Date which can however, be extended upon request of Our Client.

Yours faithfully,

Signature:_____

Name:_____

Designation:_____

Bank Stamp:

BANK GUARANTEE AGAINST
"SPECIMEN FOR PERFORMANCE/WARRANTY GUARANTEE"

Guarantee No: _____Date_____ Amount:_____ Valid upto:_____

In Favour of:

National University of Technology (NUTECH), IJP Road, I-12, Islamabad

Subject: **In compliance with terms of Performance/Warranty Guarantee Bank Guarantee**

Contract No: _____ dated___

Dear Sir,

1. Whereas your good-self have entered into Contract No: _____ dated_____with M/s [Firm Name] Located at [Firm Address], Herein after referred to as our customer and that one of the conditions of the Contract is submission of Bank Guarantee by our customer to your good-self for a sum of [Amount].

2. Incompliance with this stipulation of subj contract, we hereby agree and undertake as under:-

a. To pay to you unconditionally on demand and / or without any reference to our Customer an amount not exceeding the sum of [Amount] as would be mentioned in your written Demand Notice.

b. To keep this Guarantee in force till [Validity Date].

c. That the validity of this Bank guarantee shall be kept two clear year ahead of the original / extended delivery period or the warrantee of the stores which so ever is later in duration on receipt of information from your office. Our liability under this Bank Guarantee shall cease on the closing of banking hours on the last date of validity of this Bank Guarantee. Claim received there after shall not been entertained by us whether you suffer a loss or not. On receipt of payment under this Guarantee, this

documents i.e., Bank Guarantee must be clearly cancelled, discharged and returned to us.

d. That we shall inform your office regarding termination of the validity of this bank Guarantee on clear month before the actual expiry date of this Bank Guarantee.

e. That with the consent of our customer you may amend / alter any term / cause of the contractor add / delete any term / clause to / from this contract without making any reference to us. We do not reserve any right to receive any such amendment / alternation or addition / deletion provided such like actions do not increase our monetary liability under this Bank Guarantee which shall be limited only [Amount .....].

f. That the bank guarantee herein before given shall not be affected by any change in the constitution of the Bank or Customer / Supplier or Vendor.

g. That this is an unconditional Bank guarantee, which shall been cashed on sight on presentation without any reference to our Customer / Supplier or Vendor.

Signature_____

Name_____

Desig_____

Bank Stamp_____

Note: No changes in the above given BG format shall be accepted.

"SELLER'S WARRANTY CERTIFICATE"

(To be provided on stamp paper)

Contract No: _____ Dated:

Validity ____ years from the date of final acceptance of the Stores.

We hereby guarantee that we are the genuine and original Source of provisioning the Stores to our Buyer. We also undertake that nothing in the manufacturing of these Stores has been obtained through unauthorized means.

1. We hereby warrant and undertake that the Stores and all the associated spares/ accessories supplied under the terms and conditions of the above Contract, are:

   a. brand new, complete in all respects, possessing good quality and standard workmanship; and

   b. liable for replacement/rectification free of charge, if during the Warranty period the same are found defective before or under normal use or these do not remain within the limits and tolerances stated under the specifications or in any way not in accordance with the terms of this Contract. All expenses incurred in removal, re-provisioning and reinstallation of such defective Stores or their parts shall also be borne by us.

2. The Warranty shall remain valid for a period of ____ years from the date of final acceptance of the Stores.

Signature & Stamp _____

_____

Name & CNIC _____

Designation: _____

Date: _____

**Sellers warranty must be provided by the Seller (firm) on Rs 100 stamp paper along with bank guarantee/CDR/Pay Order without changing a word. BG with additional clauses will be rejected.

CHECK LIST

(This checked list must be attached with your technical offer, duly filled and

Signed by authorized signatory)

Tender No_____ **Date_____**

1	Tender Processing Fee	a. Tender processing fee ref no_____ b. Bank_____ c. Amount_____	
2	EM/ Bid Bond	a. EM/ Bid Bond ref no_____ b. Bank _____	
3	Form Annex A, A-1, B and C signed by Authorized Signatory	**Yes**	**No**
4	Offering specification of items as per IT	**Yes**	**No**
5	Accounting unit/Qty as per IT	**Yes**	**No**
6	Delivery Schedule as per IT	**Yes**	**No**
7	Country of origin of store_____		
8	Name of OEM:-_____		
9	Original Performa invoice (Mandatory)	**Yes**	**No**
10	Certified that there is no Deviation from IT conditions/ there is deviation from IT condition as per fol details	**Yes**	**No**
11	Blacklisting certificate on stamp paper. it is certified that our firm is neither default nor black listed by any govt organization directly or indirectly	**Yes**	**No**

Note: Fill and/or mark Yes/No where required

_____

Signature of Firm Auth Signatory