TENDER DOCUMENTS

Electrical Lab Equipment

NUTECH / SCM / Electrical Lab Eqpt (PSDP) 2020 / TD-110

NATIONAL UNIVERSITY OF TECHNOLOGY

TENDER NOTICE

National University of Technology (NUTECH)

NUTECH / SCM / Electrical Lab Eqpt (PSDP) 2020 / TD-110

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

1. Tender documents containing terms, conditions and detailed specifications of items (including draft contract) can be downloaded from NUTECH website "https://nutech.edu.pk" w.e.f **17 Jan 2020**.
2. Quotations shall be submitted as per requirement of the tender documents.
3. 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).
4. Sealed bids with detailed specifications should reach on the following address latest by **1030 hours on 20 Feb 2020.** Late submission will not be entertained.
5. Bids will be opened at **1100 hours** on **20 Feb 2020 at** SCM Office.
6. Project is to be completed in **120 days** from the date of award of contract.
7. 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.

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, 20 Feb 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 Mechanical Lab Equipment.

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

   a. **Technical Offer.** Please also note that Technical Offer should contain only Annexure-A, special conditions compliance & 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 as well. Only technical details (literature/brochures/relevant material) without mentioning the financial aspect of the offer in duplicate would be enclosed in an envelope. In technical proposal, all items must have the brand names, model number, manufacturer 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.**. SCM Office will not accept any excuse of delay occurring in post. 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 commercial offer. Conversion rate of Foreign Exchange (FE) / Local Currency (LC) components will be considered with effect from opening of commercial offer.

7. **Documents.** Following information's / 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, 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 or made subject to confirmation later.
b. There is any deviation from the General/ Special / Technical Instructions.
c. Offers are found conditional or incomplete in any respect.
d. Tender processing fee (with tech offer) and 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 contract.

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

11. **Terms of Payment/ LC Charges** In case of CPT/FOB (all categories) contracts 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 after completion of warranty period.

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

14. **Freight charges /Custom clearance:** Custom clearance and all freight related will be supplier's responsibility. NUTECH will provide applicable exemption certificates and documents. 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 a BG as stipulated above depending on the value /criticality of the tender equipment /stores.

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** Supplier is not allowed to sublet wholly or part of the contract to any other firm /company without prior permission of the purchaser's .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 Rector NUTECH and two arbitrators, one to be nominated by each party who before entering upon the reference shall appoint an umpire by mutual agreement, and if they do not agree a judge of the Superior court will be requested to appoint the umpire. 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 the purpose of getting the export licenses/permit on behalf of the supplier for the export of the Contracted good /stores.

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 /inspector as detailed by the technical authority of respective department on behalf of the NUTECH 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 or 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 according 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 of 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. Marking of packages /instruction will render the store liable to reject .Any loss occurred /demurrage paid due to wrong marking will be make good by the supplier

27. **Original Performa Invoice**: Please ensure Original Performa invoice has fol components incorporated:-

a. HS Code
b. Incoterm
c. Payment Terms
d. Origin of good
e. Port of shipment
f. Port of departure
g. Seller & Buyer acceptance (on Performa Invoice)
h. Invoice Date
i. Latest date of shipment
j. Seller complete bank detail

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 on stamp paper 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** 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 contract value, in any way.

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 and binding on the Supplier / Seller.

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

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

Deputy Director

Supply Chain Management Office

Annex-A

Technical Specifications

NUTECH / SCM / Electrical Lab Eqpt (PSDP) 2020 / TD-110

Ser	Part No	Items	Description	A/U	Country of Origin	Qty Req	Bidder Compliance		
							Yes	No	Alternate
1.		Electrical Machines Trainer	Electrical Machine Trainer comprising the following modules as per quantity mentioned against each: (a) Complete Electrical Machines Training Systems (Qty-3) (b) Open Lab Electrical Machines Training Systems (Qty-2) Total Qty (Req) = 3+2= 5	No	Europea n/ USA	5 (3+2)			
	a	**Module (a)**	**Complete Electrical Machines Training Systems with following Equipment**						
	a(i)	**Motor Driven Power Supply**	**Motor Driven General Purpose Power Supply (Programmable)** • Suitable for fixed/Variable ac and dc current. • Emergency Mushroom head. Over speeds Protection. • Variable ac: 3x0÷380V, 2A & 3x0÷240V, 3A • Fixed ac: 3x380V +N, 10A, 3x220V, 3A • Variable dc: 0÷240V, 4A, 0÷225V, 1A • Fixed dc: 220V, 4A • Power Supply: 3x380V+N, 50/60Hz						

	a(ii)	**DC Machines**	**DC Machines-1:** **Direct Current Generator** **Series, Shunt and Compound Excitation** It can be used as a motor 2800 r.p.m. Voltage: 220V Current: 1.18A Excitation: 190V/0.1A **DC Machines-2:** **Direct Current Motor** **Series, Shunt and Compound Excitation** It can be used as a Generator Power: 260W. Speed: 2800 r.p.m. Voltage: 220V Current: 1.18A Excitation: 190V/0.1A						
	a(iii)	**Three Phase AC Motors**	**Three Phase AC Motors-1:** **Squirrel Cage Three-Phase Asynchronous Motor** Power: 370W. Speed: 2650 r.p.m. (50Hz), Connections: Star/triangle. Voltage: 220/380V Δ/Y Current: 2/1.1A Δ/Y. **Three Phase AC Motors-2:** **Three- Phase Wound Rotor Asynchronous Motor** Power: 370W. Speed: 2650 r.p.m. (50Hz), Connections: Star/triangle. Voltage: 220/380V Δ/Y Current: 2/1.1A Δ/Y.						
	a(iv)	**Single Phase AC Motors**	**Single Phase AC Motors-1:** **Capacitor Motor** Power: 370W Speed: 2720 r.p.m. Frequency: 50Hz. Voltage: 220 V, Current: 3A **Single Phase AC Motors-2:** **Universal Motor**						

			Speed: 3000 r.p.m. Frequency: 50Hz. Voltage: 220 Vac/220Vdc. Current: 3.5Aac/3Adc **Single Phase AC Motors-2:** **Repulsion Motor** Speed: 3000 r.p.m. Frequency: 50Hz. Voltage: 220 Vac/220Vdc. Current: 3.5Aac/3Adc						
	a(v)	**Single Phase Transformer**	**Single Phase Transformer** Corer type transformer with split windings. Power Rated: 300VA Primary Voltage: 127/220/380V Secondary Voltage: 2 x 110V It is also used as an Auto-Transformer						
	a(vi)	**Three Phase Transformer**	**Three Phase Transformer:** Column-type transformer with split windings. Power Rated: 300VA Primary Voltage: 2 x 110V (Phase) Secondary Voltage: 2 x 110V (Phase) It is also used as a Single-Phase Transformer						
	a(vii)	**Measuring Modules**	**Electrical Power Digital Measurement Unit:** DC Voltage: 500V AC Voltage: 500V DC Current: 9.9A AC Current: 9.9A Power: 600W **Mechanical Power Digital Measurement Unit:** Torque: 0 ÷ 1.999 Nm; Speed: 6000 rpm Power: 600W Dc Output: 0 ÷ 220V, 0.6A Power Supply: 220V, 50/60Hz						
	a(viii)	**Load Cell**	**Load Cell:** Resistance electronic strain-gauge 150N						

			Range, to be mounted on the braking system to measure the mechanical torque.						
	a(ix)	**Braking Assemblies:**	**Eddy-Current Brake (Electromagnetic Brake)** Smooth roll and salient pole stator Speed: 5000 rpm Power: 450W Power Supply: 250Vdc						
	a(x)	**Power Supply for Break**	**Power Supply for Breaking Systems:** Output: 0÷120V, 2 A or 0÷220V, 1 A. Power supply: single-phase from mains						
	a(xi)	**Universal Base**	**Universal Base for Motors:** Anti-vibration rubber feet, fixing of two machines and with coupling guard and locking of the rotor of the slip-ring Asynchronous machines.						
	a(xii)	**Connecting Leads**	Connected Leads						
	a(xiii)	**Loads and Accessories**	**Capacitive Load:** Single Phase or Three Phases Capacitive step-variable Load Power: 3 x 105VAr Voltage: 220/380V Δ/Y. **Inductive Load:** Single Phase or Three Phase Capacitive step-variable Load Power: 3 x 100VAr Voltage: 220/380V Δ/Y **Resistive Load:** Single Phase or Three Phase Capacitive step-variable Load Power: 3 x 110W Voltage: 220/380V Δ/Y.						
	a(xiv)	**Accessories**	Starting Rheostat, Excitation Rheostat, Star/Delta Starter,						

			Pole Switching Unit, Other accessories which will be useful in trainer						
	b	**Module (b)**	**Open Lab Electrical Machines Training Systems with following Equipments**						
	b(i)	**SET OF COMPONENTS**	It includes the following components: Base plate Supports with bearing Coupling joints Flexible coupling Electronic speed transducer Assembling screws Wrenches DC stator AC stator Rotor with commutator Brush holder with 2 brushes Cage rotor Ring rotor Brush holder with 6 brushes **The short description of the above given below:** This system is a complete set of components and modules suitable for assembling the rotating electric machines, both for direct current and for alternating current. Besides, a magnetic probe is foreseen to display the magnetic fields and a transparent covering, for safety reasons, prevent students from the accidental contact with the rotating parts. The **AC STATOR** is composed of a metal frame supporting the laminated magnetic circuit, because interested by a flux variable in time, and the electrical winding. The sheet iron pack is 60 mm long, with internal diameter of 80 mm and external one of 150 mm and it presents 24 half-						

			closed slots inside of which there is a double three-phase winding: the beginnings and the ends of the different phases are shown outside the stator on a suitable educational terminal board. The winding is a double layer one of the long coil lap type, with winding span 6 (1÷7). Every slot contains two coils of 19 turns each of enameled wire of diameter 1.12 mm. The **SQUIRREL CAGE ROTOR** is composed of a shaft to which a pack of magnetic sheet irons is fixed, where the slots suitable to contain the rotor winding are set. The sheet iron pack is 60 mm long, with external diameter of about 78 mm. To avoid the phenomenon of the motor crawling in starting phase and to reduce the noise, the slots are inclined as regards the stator ones. The rotor winding is composed of the squirrel cage. The cage is carried out by setting in every rotor slot some conducting bars that are closed in short-circuit at both ends by means of some conducting rings. The rotor winding can be therefore considered a multi-phase winding, with a single conductor for pole- phase, so it does not present its proper pole number but it assumes one that is equal to the stator winding one. The **RING ROTOR** is composed of a shaft to which the collector rings and a magnetic sheet iron pack are fixed: the iron pack has 21 semi-closed slots suitable to contain the winding. The sheet iron pack is 60 mm long, with external diameter of about 78 mm. To avoid a noisy mechanical running the rotor slots are inclined as regards the stator ones. The rotor winding is composed of coils and it is two pole three-phase. The winding is a double layer one of the long coil						

			lap type, with winding span 9 (1-10). Every slot contains two coils of 8 turns each of enameled wire of diameter 1.5 mm. The winding is star connected and it is subordinate to the collector rings while the star centre is internal and not accessible. The terminals of the rotor winding are accessible by means of the collector rings on which the bushes supported by a brush holder graze. The brushes are two for each phase and they are subordinate to an external terminal board that shows the synoptic of the rotor winding. The **DC STATOR** is composed of a metal frame supporting the laminated magnetic circuit, with 2 main poles and 2 inter poles, and the electrical windings. The sheet iron pack is 60 mm long, with internal diameter of 80 mm. On the poles the coils are wound whose terminals are shown on a suitable educational terminal board. The **DC ROTOR** is composed of a shaft to which the segment commutator is fixed and of a magnetic sheet iron pack where 20 semi-closed slots suitable to contain the electrical winding are set. The sheet iron pack is 60 mm long, with external diameter of about 80 mm. The winding is a double layer one of the long coil lap type, with winding span 9 (1÷10). Every slot contains two coils with two sections of 5+5 turns carried out with enameled wire of diameter 1.12 mm. The winding is subordinate to the 40 segments of the commutator on which two brushes are supported by a brush holder graze. The brushes are subordinate to terminals set on two external boards that show the synoptic of the rotor winding.						

	b(ii)	**POWER SUPPLY**	POWER SUPPLY Outputs in ac: • Three-phase: 24 V/14 A, 42V/10A • Single-phase: 0 – 48 V/5 A, 0 – 10 V/12A Outputs in dc: • 32 V/14 A, 42 V/10 A, 0 – 40 V/5 A, 0 – 8 V/12 A Three-phase power supply from mains. Complete with over-speed protection						
	b(iii)	**ELECTRIC AND SPEED MEASUREMENT**	Power supply: 100-240 Vac 50/60 Hz •Vac/Vdc measurement range: 0-65V •Iac/Idc measurement range: 0-20A • Speed measurement range: 0- 4000 rpm at 50Hz • 0-6000 rpm at 60Hz Communication: Modbus RTU RS485 • Encoder resolution: 5 pulses / revolution						
	b(iv)	**LOADS AND RHEOSTAT**	resistors: • 3x15 Ohm, 90 W each, 1 Ohm + (0 - 2 Ohm), 80 W capacitors: 3 x 80 µF, 150 V • rheostat: 0 - 80 Ohm, 1 A						
	b(v)	**ADAPTER BRACKET**	Necessary for connecting the locking device, the brake or the drive motor.						
	b(vi)	**LOCKING AND ROTATING**	Suitable for locking and rotating the rotor of slip-ring induction motors to obtain an induction regulator and phase transformer						
	b(vii)	**POLE CHANGING**	Switch to change the number of poles on motors.						
	b(viii)	**PARALLEL BOARD**	Rotating light synchronoscope to perform the parallel connection between synchronous generators or between the alternator and the mains.						
	b(ix)	**ELECTROMAGNETIC**	Smooth roll rotor and salient pole stator For three-phase squirrel cage induction motors.						

		BRAKE&STAR/DELTA STARTER							
	b(x)	**STARTING AND SYNCHRONIZATION**	Rotor starter for three-phase slip ring motors and excitation device for synchronization with the mains.						
	b(xi)	**FAULT SIMULATORS**	Set of 4 masks to insert simulated faults in the machines of the OPENLAB system. The set includes: • FAULT SIMULATOR FOR A THREE-PHASE CAGE MOTOR - Short-circuit between two phases - Break-up of a stator phase - Break-up of two phases - Internal short-circuit • FAULT SIMULATOR FOR A SLIP RING MOTOR - Short-circuit between two phases - Break-up of a stator phase - Internal short-circuit • FAULT SIMULATOR FOR A SINGLE-PHASE CAPACITOR MOTOR - Unsuccessful starting of the motor • FAULT SIMULATOR FOR A COMPOUND EXCITED DC MOTOR - Unsuccessful starting of the motor - Break-up of a stator phase - Shunt excitation circuit reversal						
	b(xii)	**Accessories**	Starting Rheostat, Excitation Rheostat, Star/Delta Starter, Pole Switching Unit, Other accessories which will be useful in trainer						
			Experimental Capabilities Flux produced by the poles Main magnetic field Intensity of the magnetic field Induced voltage Inter pole effect						

			No-load magnetic neutral axis Rotating magnetic field 3-phase squirrel cage motor, 2 poles, 24 VΔ 3-phase squirrel cage motor, 2 poles, 42 VY 3-phase squirrel cage motor, 2 poles, 24 VΔΔ 3-phase squirrel cage motor, 2 poles, 42 VYY 3-phase squirrel cage motor, 4 poles, 24 VΔ 3-phase squirrel cage motor, 4 poles, 42 VY 3-phase motor, 4/2 poles, 42 VΔ/YY Split phase motor Capacitor start and run motor 3-phase motor with wound rotor, 2 poles, 42 VYY Phase shifter Induction regulator 3-phase synchronous induction motor, 2 poles, 24 VΔ 3-phase synchronous induction motor, 2 poles, 24 VΔΔ DC motor with separate excitation DC motor with shunt excitation DC motor with series excitation DC motor with compound excitation, long shunt DC motor with compound excitation, short shunt Single phase series motor Repulsion motor Synchronous motor winding resistance Synchronous motor no-load test Synchronous motor short-circuit characteristics Synchronous motor short-circuit test Synchronous motor Behn-Eschenberg's method Synchronous motor load test Synchronous motor conventional efficiency Parallel connection of the alternator with the mains Alternator as synchronous motor						

			DC generator winding resistance DC generator test of the no-load motor (Swinburne) DC generator no-load e.m.f. DC generator excitation characteristics Separate excitation dynamo Shunt excitation dynamo Series excitation dynamo Compound excitation dynamo						

2.		**Power Electronics Trainer (Complete Package)**	**Selenium rectifier Qty. 1(per unit set)** Rated alternated voltage: 30 Vrms Rated continuous voltage: 24 Vav Rated continuous current: 10 Aav **Silicon diode Qty. 4(per unit)** Direct average current: IFAV = 12 A max. Direct non repetitive overload current: IFSM = 75 A (tp = 10 ms) Repetitive peak reverse voltage: URRM = 1000 V Recovery reverse time: trr = 65 ns max. **Group of diodes Qty. 1(per unit)** Six fast acting silicon diodes with RCD protection network suitable for realizing non-controlled rectifying circuits. Direct average current: IFAV = 12 A Direct non repetitive overload current: IFSM = 75 A (tp = 10 ms) Repetitive peak reverse voltage: URRM = 1000 V Recovery reverse time: trr = 65 ns max. **SCR Qty. 1(per unit)** Direct average current: ITAV = 7.6 A max. True RMS value of the direct current: ITRMS = 12 A Max. repetitive reverse voltage: URRM = 800 V Trigger current: IGT = 15 mA max. Trigger voltage: **Group of SCR Qty. 2(per unit)** Six silicon controlled rectifiers with RCD protection network used for realizing controlled rectifiers and inverters. Direct average current: ITAV = 7.6 A max. True RMS value of the direct current: ITRMS = 12 A Max. repetitive reverse voltage: URRM = 800 V	No	Europea n/ USA	2			

			Trigger current: IGT = 15 mA max. Trigger voltage: UGT = 1.5 V max. I2t = 72 A2s **Triac Qty. 1(per unit)** Bidirectional thyristor used for the control in alternated current. Complete with RC suppressor network. True RMS value of the direct current: ITAV = 8 A max. Non-repetitive peak current: ITSM = 70 A, 50Hz (77A, 60Hz) Max. repetitive reverse voltage: UDRM = 800 V Trigger current: IGT = 25 mA max. (all the quadrants) Trigger voltage: UGT = 2.5 V max. State keeping current: IH = 25 mA max. I2t = 24 A2s **MOSFET Qty. 1(per unit)** N-channel enhancement mode power MOS with integrated reverse diode (FRED, Fast Recovery Epitaxial Diode) used as very fast switch in switching regulators and inverters. Drain-source voltage: UDS = 400 V Continuous drain current: ID = 10 A Drain-source on-state resistance: RDS(on) = 0.55 Ω Gate-source voltage: UGS = +-20 V **IGBT Qty. 2(per unit)** N-channel Insulated Gate Bipolar Transistor (IGBT) with anti parallel hyper fast protection diode used as very						

			fast switch in switching regulators and inverters. Collector-emitter voltage: UCES = 600 V Continuous collector current: Ic=24 A at Tc=25ºC Collector-emitter saturation voltage: UCEsat = 1.8 Vtyp at Ic=15 A Gate-emitter voltage: UGE = ± 20 V **Group of IGBT Qty. 1(per unit)** 4 N-channel Insulated Gate Bipolar Transistors (IGBT) with anti parallel hyper fast protection diode used as very fast switches in switching regulators and inverters. Collector-emitter voltage: UCES = 600 V Continuous collector current: Ic = 24 A at Tc = 25ºC Collector-emitter saturation voltage: UCEsat = 1.8 Vtyp at Ic=15 A Gate-emitter voltage: UGE = ± 20 V **Bridge three phase rectifier Qty. 1(per unit)** Non-controlled three-phase rectifier in six pulse bridge connection B6UK for the generation of a DC voltage from a three phase mains. Rated alternating input voltage: UVN = 400 V Direct output voltage: Ud = 540 V Rated direct current: IdN = 10 A Surge forward current: IFSM = 300 A I2t = 400 A2s Voltage drop: UF = 1 V per diode **SCR with turn off circuit Qty. 1(per unit)** Main SCR and auxiliary SCR, complete with RC uppressor circuit. Direct average current: ITAV = 13 A max. Max. repetitive reverse voltage: UDRM = 800 V tq = 35 ms						

			Block diodes and flywheel, complete with RC suppressor circuit. Max. repetitive reverse voltage: UDRM = 600 V IAV = 8 A Turn off capacitor: C = 2 µF Oscillation coil: L = 1 mH Shunt for the measurement of the currents in each branch: 4 x 0.1 Ω **DC Power Supply Qty. 1(per unit)** Laboratory power supply with two fixed voltage outputs and protected against short-circuit. Output voltages: +15 V ; 0 V ; -15 V Output current: 2,4 A (3 A for a short period) Power supply: single-phase from mains Two led (+15 V ; -15 V) for the indication of the nominal voltage. Mains switch with pilot lamp **Voltage Reference Generator Qty. 1(per unit)** Power supply: +15 V ; 0 V ; -15 V Range of the continuous regulation reference signal: from - 10 V to + 10 V, from 0 to + 10 V Range of the step reference signal: from - 10 V to + 10 V, from 0 to + 10 V Switch for selecting between internal potentiometer reference signal and external reference signal Switch for selecting between the 0 / ±10 V range and the 0 /+10 V range **Trigger point limiter Qty. 1(per unit)** Stability limit for rectifier: 0° to 180° Stability limit for inverter: 180° to 0° Power supply: +15 V / 0 V / - 15 V **Two pulse control unit Qty. 1(per unit)**						

			Power supply: +15V/ 0V / - 15V (25mA) Synchronization voltage: 1 to 440 V Control voltage Uc: 0 V to 10 V Trigger angle: 180° to 0° Number of outputs: 2 x 2 Possibility of pulse train or single pulse. Possibility of selecting two natural switching points: 0° and 30°. Inhibit voltage: UINH = 15 V (open): trigger pulses. UINH = 0 V: no trigger pulses. **Six pulse control unit Qty. 1(per unit)** Power supply: +15V/0V/- 15V (300mA) Synchronization voltage: 1 to 440 V Analogue control voltage Uc: 0 to 10V Digital TTL control: DWH = FH...FFH (15...255)10 Trigger angle: 180° to 0°(300°...120°/60°...240°) Number of outputs: 3 x 2 Possibility of pulse train or single pulse. Possibility of excluding the secondary pulse. Possibility of selecting three natural switching points: 0°, 30°and 60°. Inhibit voltage: UINH = 15 V (open): trigger pulses. UINH = 0 V: no trigger pulses **PWM, PFM, TPC control unit Qty. 1(per unit)** Power supply: +15V/0V/- 15V (600 mA) Control voltage: Uc: 0 to 10V PWM: 20-200 Hz/0.2-2 kHz/2-20 kHz Duty cycle D = ton/T = 0-0.95 PFM: 5-50 ms/50-500 ms/0.5-5 s Frequency: 20 Hz to 20 kHz TPC: Hysteresis: UH = 0 to 2 V						

			Number of outputs: 2 x 2, with led indication of the status Output amplifier: threshold voltage 5 V, short-circuit proof Inhibit voltage: UINH = 15 V (open): trigger pulses. UINH = 0 V: longer pulses at certain outputs only. **Run-up control unit Qty. 1(per unit)** Power supply: -15 V/0 V/ 15 V Input signal range: Ui = -10 V ... 10 V Fine adjustment of the slew-rate: 0.5 . . . 50 V/s Fine adjustment of the voltage gain: 0.1 . . . 1 Inhibit voltage: UINH = 0 V: zero output voltage U0 and output UINH = 15 V UINH = 15 V (open): output voltage U0 runs up and output UINH =0 V **PID Controller Qty. 1(per unit)** Standard industrial controller that can be used as P, PI, PD or PID controller in the closed loop automatic control systems. Power supply: +15 V ; 0 V ; -15 V Input summing node for two different reference variables UR and UC and for one controlled variable UA. Signal voltage range: -10V .... +10V Parameters of the controller continuously adjustable Proportional gain: Kp = 0 ... 1000 Time of the integral action: TI = 1ms ... 100s Time of the derivative action: TD = 0.2ms ... 20s Reset input of the integral controller.						

			Output summing node to add or subtract noise variables. Measurement terminal for the error signal. Adjustment screw for the output offset. Three led indicator of the sense of deviation. Coarse and fine adjustment of the proportional gain Kp, of the time of the integral action TI and of the time of the derivative action TD. Indicator of over-range: led "over" on when the output voltage is higher than 10 V or lower than -10 V. Input Ioff for resetting the I controller. **Absolute value generator Qty. 1(per unit)** Power supply: -15 V/0 V/+15 V Input signal range Ui: -10 V . . . + 10 V Adjustable gain: 0 . . . 1 Inverting control input: UINV = 0 V: the input signal is inverted UINV = 15 V or disconnected: the input signal is not inverted Inhibit voltage: UINH = 0 V: the output signal is zero UINH = 15 V (open): the absolute value circuit is active **Adaptive PI controller Qty. 1(per unit)** Double compact PI controller for use as current controller in dc servo drives. Power supply: -15 V/0 V/+15 V Input summing point for two different reference variables UR and UC and one controlled variable UA. Signal voltage range: -10 V . . . + 10 V Continuously adjustable parameters of the two controllers:						

			proportional gain Kp = 0 . . . 1000 integral action time TI = 0.2 ms . . . 20 s Integral element reset by switch or via external signal. Regulator selection by switch or via external signal. **Gain and Offset Adjust Qty. 1(per unit)** Power supply: +15 V ; 0 V ; -15 V Voltage interval of the input signal: -50 V, ..., +50 V Adjustable level through the setting of the gain: 0 ....1, 0 .... 10, 0 .... 100 Attenuation of the pulse signals. Time constants: 0,1 .... 10 ms ; 10 .... 100 ms Offset voltages that can be connected: -10 V .... +10 V Coarse setting through rotary switches. Potentiometer fine setting. **Mains transformers Qty. 1(per unit)** Three-phase transformer able to supply single and three phase voltages as well as a rectified voltage for the excitation of the dc machines. Three pilot lamps for signaling the mains voltage. AC output through isolation transformer: 3 x 90 V/1.5 A with 3 intermediate sockets at 45 Vac. DC output, non isolated from mains: 1 x 220 V/1 A, switch with pilot lamp and magneto-thermal protection 1 A **Capacitors Qty. 1(per unit)** Two electrolytic high performance capacitors. Rated value: 2 x 1000 µF Rated voltage: 385 V Protection against polarity inversion. Discharge resistance: 330 kΩ (t = 330 s)						

			Super-fast fuses Qty. 2(per unit) Nominal voltage: 660 Vac Nominal current: 3 x 6.3 A and 3 x 10 A **Switching transformer Qty. 1(per unit)** Ferrite core N27 without air gap. Primary: 2 x 115 V, 2 x 48 turns Thermal protection: 2 x 0.6 A Secondary: 2 x 15 V/ 4.5 A, 2 x 7 turns Inter-winding shield. Rated power: 135 VA Rated frequency: 15 kHz **Current transformer Qty. 1(per unit)** For potential-free measurements of ac currents in single and three-phase without neutral. Current: 10 A Unsmoothed output voltage for synchronization. Smoothed output voltage for current regulator. Transformation ratio: 2 V / 1 A and Insulation voltage: 3 kV **Trigger pulse switch Qty. 1(per unit)** For switching the trigger pulses from the control unit to double converters in 4-quadrant systems. Two pulse inputs and Two control inputs. Eight electrically isolated pulse outputs and Power supply: +15 V **Switching logic Qty. 1(per unit)** Input Xn for torque comparator (speed set point value). Input Xi for current comparator with adjustable limit threshold. Output SA and SB for the corresponding inputs of the trigger pulse switch with led indication of the active converter. Output INV for the corresponding inverting input of the absolute value generator.						

			Output INH for the corresponding inhibit input of the two pulse control unit, with adjustable delay time from 10 ms to 2 s and led indication of the commutating time. Current comparator output C for EXT selection input of the active elements of the adaptive PI controller. Power supply: +15 V/0 V/-15 V **Function generator Qty. 1(per unit)** Functions: sine / triangle / square wave / square wave with variable duty cycle. Frequency range: 10 Hz . . . 100 kHz in 4 decades. Output voltage: 0 V to 20 Vpp adjustable Two additional outputs with attenuator: -20 dB/ -40 dB TTL output for triggering. VCO input, AC coupled. Power supply: single-phase from mains **Voltage divider 20:1 Qty. 1(per unit)** Electronic voltage divider used as an interface between the dc machines (200 V) and the automatic control circuits (-10 V …+15 V). Possibility of capacitive filter with time constant 0.1 s. Protection against over voltages up to 1000 Vdc. Power supply: +15 V / 0 V / - 15 V **Universal Load Qty. 1 (per unit)** Ohmic, inductive and capacitive load suitable for the experiments in the power electronics laboratory. a) Load resistors: 3 x 100 Ω/1 A and Protection with fuses: 3 x T1.25 A Possibility of connecting in series (300 Ω), in parallel (33.33 Ω) or in star and delta b) Load inductors: 2 x (12.5 - 50) mH/2.5 A						

			Possibility of connecting in series (100 mH) and in parallel (6.25 mH). c) Load capacitors: 4-8-16 µF/450 Vac Possibility of connecting in parallel (28 µF). Discharge resistor: 1 kΩ/0.22 A **Socket with lamps Qty. 1(per unit)** Three lamp-holders E14. Complete with three incandescent lamps: 40 W/220 V. Possibility of connecting in parallel. **Stabilized power supply Qty. 1(per unit)** The power supply has two sections: Regulated variable voltage section, used to supply the armature of dc motors. Output: 0 ÷ 240 Vdc, 5 A Drive: manual or external via 0 ÷ 10 Vdc signal Constant voltage section, used to supply the excitation circuit of dc machines. Output: 220 Vdc, 1 A **Phase control fault simulator Qty. 1(per unit)** Double time-constant standard light dimmer circuit consisting of triac, diac, two control potentiometers, resistors and capacitors. A total of 20 faults can be switched on using switches located behind a cover. Typical faults: interruptions, short-circuit, faulty components and faulty design. Power supply: 110 to 230 V, 47-63 Hz Ohmic load: 1.2 kW max **EMI Filter Qty. 1(per unit)** Inductances on the line: 0.4 mH Capacitors between conductors and neutral: 100 nF Capacitor between neutral and ground: 22 nF						

			Isolation amplifier Qty. 1(per unit) Isolation amplifier, channels A, B, C, E: - Frequency range: dc to 80 kHz. - Max Input voltage: Max 620 Vdc/460 Vac Input resistance Ri = 1 MW in all ranges - Input current (between 0 and I) Max: 10 A continuous; 16 A for t< 15 min; 20 A for t<2 min. Internal resistance: 30 mW in all ranges Five outputs: A, B, C, D, E with led for over range Indication Output resistance RO: 100 W - Multiplexer: Mux channels, selectable: 1 to 8 (4 x signal; 4 x zero line) Gain attenuator, adjustable: 0.2 to 1. Y-position, adjustable: -8 V to + 8 V. Mux frequency, adjustable: 50 kHz to 500 kHz (typical). Two BNC outputs for oscilloscope Mathematical module and filter: - Functional modes for channel D: Addition A+B; subtraction AB; multiplication AxB/10 or AxB; reconstruction of the phase voltage LIN(A, B, C) from the line-to line voltages; channel E switched into channel D for multiplexing. - Filter Low pass active filter of the 2° order required for the recovery of the fundamental wave out of the PWM signals. Cut-off frequency: 1 kHz. Space vector indicator: - Voltage vector: indication with 7 led. - Magnetic flux vector: BNC outputs X e Y for oscilloscope. Power supply: - Single-phase from mains Frequency: 50/60 Hz.						

			Support with 3 shunts 1 ohm Support with 3 shunts, with different connection possibilities. Resistance: 1 Ω ; Accuracy: ± 1% ; Max. current: 2.5 A **Support with 3 shunts 0.1 ohm Qty. 1(per unit)** Support with 3 shunts, with different connection possibilities. Resistance: 0.1 Ω ; Accuracy: ± 1% ; Max. current: 8 A **Frequency converter Qty. 1(per unit)** Transistor pulse-converter with pulse driven voltage source inverter and transistor for the generation of a three-phase, variable frequency and variable voltage system. In conjunction with the PWM control unit this device is used for the realization of a frequency converter for asynchronous motor drive. Output voltage: 3 x 0...230 V Output current: 3 x 8 A max. Supply voltages: power circuit, 1 x 255 V max, 50/60 Hz control circuit, single-phase from mains **PWM Control Unit Qty. 1(per unit)** Control unit used in conjunction with the frequency converter to build a voltage-source inverter which operates with PWM control. All of the control, monitoring and measuring functions are integrated into the control unit while the frequency converter contains solely the power components.						

			A PWM modulator controls the power transistors of the inverter and thus generates a sine-shaped motor current. Modulation possibilities: PWM, VVC, trapezium shaped and block type. **PC Interface Qty. 1 (per unit)** IN/OUT connector for connection to the control unit and display for the visualization in hexadecimal of the control word. Two AO lines for analogue outputs: ±10 V. Six AI lines for analogue inputs: ±10 V The analogue signal is obtained from a D/A converter with 12 bit resolution. Auxiliary relay with led to show the switching status. USB connection. **Power Electronics Software Qty. 1(per unit)** With this software it is possible to measure the wave forms for voltage and current that can be found in the static inverter and converter circuits. Through a microprocessor based interface it is possible to detect the wave forms and to send the controls to obtain trigger angles through software. On the screen the true RMS value, the mean value, the power and other parameters are calculated in order to allow the evaluation of the efficiency of the different circuits. The software features a very accurate graphic presentation and a user friendly interface with the end user. **Induction Motor Control Software Qty. 1(per unit)** With this software it is possible to realize the PWM, VVC, trapezium shaped and block type,						

			full and half frequency control of the frequency converter and to do the acquisition of the mechanical characteristics of the induction motor under testing. Voltages, currents and other main characteristics are calculated both in numbers and as curves. The software features a very accurate graphic presentation and a user friendly interface with the end user. **Variable Three Phase Transformer Qty. 1(per unit)** Power supply: three-phase from mains Rated output: 550 VA Secondary phase current: 1.25 A Secondary voltage: 0 to 440 V The voltage is set by means of a variable autotransformer with rotary knob and the output is floating by means of an isolating transformer with subdivided secondary winding. Fitted with mains lamp and motor circuit breaker. **Battery stack Qty. 1(per unit)** Two rechargeable batteries, maintenance free and Capacity: 1.8 Ah/12 V **Tachometer Qty. 1(per unit)** Speed ranges: 1500/3000/6000 rpm Accuracy class: 1.5 Output voltage: 1 V/1000 rpm **Single phase supply unit Qty. 1(per unit)** Power supply: single-phase from mains Cam operated 2-pole mains switch 16 A Automatic circuit breaker: 10 A, operated by thermal effect						

			Output terminals L and N, with pilot lamp Pilot lamp for indication of mains false polarity **Three phase supply unit Qty. 1(per unit)** Power supply unit for three-phase connection with 4-pole cam mains switch. 25 A current operated earth leakage circuit breaker, sensitivity 30 mA. Triple-pole motor protection switch: 6.3 to 10 A. Three-phase indicator lamps. Output through 5 safety terminals: L1, L2, L3, N and PE. **Digital AC/DC Multi-range Power meter Qty. 1(per unit)** • Automatic Scaling • Current range: 0-20 Iac/dc 20 - 100Hz • Voltage range: 0-750 Vac/dc 20 - 100Hz • Power range: 0-1000W, VAR and VA • Accuracy: +/- 0.5% • Resolution: 16bits • Refresh rate : 0.5s • Power supply: 90-260 Vac 50/60Hz • Power consumption: 3 VA • Communication: Modbus (RS485) **True rms meter Qty. 2(per unit)** Voltage: 0 .. 1000V DC 0 .. 1000VACpp 0 .. 750VACrms Current: 0 .. 20 A Continuous overload protection in all ranges. **Moving iron voltmeter Qty. 1(per unit)** Scale: 50 divisions Range: 125-250-500 V Range changeover switch. **Moving coil ammeter Qty. 1(per unit)**						

			Scale: 50 divisions and Range: 2.5 A **Asynchronous squirrel cage three phase motor** **Qty. 1(per unit)** Squirrel cage three-phase asynchronous induction motor, with three-phase stator winding and squirrel cage buried in the rotor. Rated power: 180 W and Voltage: 380/690 V Δ/Y **Slip ring three phase asynchronous motor** **Qty. 1(per unit)** Induction motor with both stator and rotor three-phase windings. Power: 250 W ; Voltage: 220/380 V D/Y ; Current: 1.65/0.95 A D/Y Excitation: 92 V, 2 A ; Frequency: 50 Hz ; Cosφ: 0.66 Speed: 1350 rpm and Thermal protection. **Rheostatic rotor Qty. 1(per unit)** Steps operated starter for three phase induction motor with slip ring rotor. Step resistance value: 3 x (12-6-3-1-0) W Current: 3 x 2.5 A max. Shunt excitation direct current motor Power: 200 W ; Voltage: 220 V ; Current: 1.5 A Excitation: 200 V, 0.067 A ; Speed: 3000 rpm Thermal protection. **Shunt excitation direct current motor Qty. 1(per unit)** Power: 160 W ; Voltage: 220 V ; Current: 0.73 A Excitation: 220V, 0.075A ; Speed: 2850 rpm Thermal protection **Shunt excitation direct current generator** **Qty. 1(per unit)**						

			Power: 160 W ; Voltage: 220 V ; Current: 0.73 A Excitation: 220V, 0.075A ; Speed: 2850 rpm Thermal protection. **Powder brake Qty. 1 (per unit)** Maximum braking torque: 12 Nm Power: 400 W ; Voltage: 0 ÷ 24 V Speed: 4000 rpm max. and Thermal protection. **Load cell Qty. 1(per unit)** Resistance electronic strain-gauge with 100 N range, to be mounted on the brake unit for measuring the mechanical torque. **Powder brake control unit Qty. 1(per unit)** Speed section: - K2 connector for the speed transducer - Circular scale three-range instrument: 1500/3000/6000 rpm - Analogue output: 1 mV/rpm Torque section - K connector for the torque transducer - Circular scale three-range instrument: 1.5/3/10 Nm - Analogue output: 1 V/Nm Brake control - Output power: 0 to 12 Vdc, 0.5 A - Manual, external or automatic regulation. Thermal protection with alarm indication and Recorder pen control. **Base Qty. 1(per unit)** Metallic structure, fire varnished, suitable for mounting the machine or the group under test. Complete with optical transducer for rotating speed detection and with anti-vibration rubber feet. **Flywheel Qty. 1(per unit)**						

			Used in deceleration tests on rotating machines for calculation of Mechanical iron and copper losses at different excitations. **Stop clock Qty. 1(per unit)** Stopwatch with LCD display. Measuring range: 9 h, 59 min, 59 s, 99/100 s and Battery: 1.5 V **Frame Qty. 2(per unit)** Metal frame for assembling the modules of the laboratory. **Connecting leads Qty. 1(per unit)** Set of connecting leads of different diameters and lengths**.** **Storage Cabinet Qty. 1(per unit)** **<u>Experimental Capabilities</u>** **ALTERNATE CURRENT - DIRECT CURRENT CONVERSION (RECTIFIERS)** **DIODES AND UNCONTROLLED RECTIFIERS** • Single pulse rectifier, ohmic load • Single pulse rectifier, ohmic-inductive load • Two-pulse rectifier, ohmic load • Two-pulse rectifier, ohmic-inductive load • Two-pulse bridge rectifier, ohmic load • Two-pulse bridge rectifier, ohmic-inductive load • Three-pulse rectifier, ohmic load • Three-pulse rectifier, ohmic-inductive load • Six-pulse rectifier, ohmic load • Six-pulse rectifier, ohmic-inductive load • Six-pulse bridge rectifier, ohmic load • Six-pulse bridge rectifier, ohmic-inductive load **SCR AND CONTROLLED RECTIFIERS**						

			Single pulse converters • Single pulse converter, ohmic load • Single pulse converter, inductive load • Single pulse converter, ohmic-inductive load • Single pulse converter, ohmic-inductive load and free-wheeling diode • Single pulse converter, ohmic-inductive load and back e.m.f. • Single pulse rectifier, ohmic-capacitive load • Single pulse converter, ohmic-capacitive load Two-pulse midpoint converters • Two-pulse midpoint converter, ohmic load • Two-pulse midpoint converter, ohmic-inductive load Multi-phase converters • Three-pulse midpoint converter, ohmic load • Three-pulse midpoint converter, ohmic-inductive load • Six-pulse midpoint converter, ohmic load • Six-pulse midpoint converter, ohmic-inductive load Drainage-coil converters • Double three-pulse star converter, ohmic load Bridge converters • Half-controlled bridge, ohmic load • Half-controlled bridge, ohmic-inductive load • Half-controlled bridge, ohmic load • Half-controlled bridge, ohmic-inductive load • Fully-controlled bridge, ohmic load • Fully-controlled bridge, ohmic-inductive load • Fully-controlled bridge, ohmic load and back e.m.f. • Fully-controlled bridge, dc motor load • Fully-controlled bridge, ohmic load and supplementary dc voltage						

			• Fully-controlled bridge, dc generator load • Three-phase half-controlled bridge, ohmic load • Three-phase fully-controlled bridge, ohmic load • Three-phase fully-controlled bridge, ohmic-inductive load **THYRISTORS & CONTROLLED AC/AC CONVERTERS** **Single-phase controllers** Single-phase ac controller, ohmic load Single-phase ac controller, inductive load Single-phase ac controller, ohmic-inductive load Single-phase ac controller, ohmic load Single-phase ac controller, ohmic-inductive load Half-controlled single-phase controller, ohmic load **Three-phase controllers** Fully controlled three-phase controller, star ohmic load without neutral Fully controlled three-phase controller, star ohmic load without neutral Three-phase controller, star ohmic load without neutral **LIGHT DIMMER FAULT SIMULATOR** Double time-constant standard light dimmer circuit consisting of triac, diac, two control, potentiometers, resistors and capacitors. Examples of exercises: • Fault-free dimmer • DIAC shorted • DIAC with high resistance • The gate of TRIAC works like a diode • Control circuit break • Assembly or component fault						

			• Trimmer shorted • Auxiliary RC circuit not included • Variable resistance R shorted • TRIAC shorted **DIRECT CURRENT to DIRECT CURRENT CONVERSION(CHOPPERS)** Main SCR MOSFET IGBT Step-down converter with SCR with turn-off circuit. PWM control. Step-down converter with IGBT. PWM control. Speed control of a dc motor Step-down converter with MOSFET. PWM control. Step-down converter with MOSFET. PFM control. Step-down converter with MOSFET. TPC control . Step-up converter with IGBT. PWM control. Step-up converter with IGBT. TPC control. Inverting converter with IGBT. PWM control. **SWITCHABLE POWER SUPPLY** Flyback converter with IGBT. PWM control. Forward converter with IGBT. PWM control. Asymmetric half-bridge forward converter with IGBT. PWM control. **DIRECT CURRENT - ALTERNATE CURRENT CONVERSION** **INVERTERS** Single-phase full-bridge dc chopper. PWM control. Single-phase full-bridge inverter. Square-wave PWM control.						

			□ Single-phase full-bridge inverter. Sinusoidal PWM control. **FREQUENCY CONVERTERS** □ Frequency converter □ Input controlled rectifier □ Output power inverter **MOTOR DRIVES** **DC MOTOR DRIVE** □ Single-quadrant drive with converter □ Single-quadrant drive with converter and armature voltage feedback □ Single-quadrant drive with converter and armature voltage feedback with RI compensation □ Single-quadrant drive with converter and tacho-voltage feedback □ Single-quadrant drive with converter and tacho-voltage feedback with inner current loop □ Two-quadrant drive (I-IV) with converter □ Two-quadrant drive (I-III) with converter □ Two-quadrant drive (I-III) with converter and tacho-voltage feedback with inner current loop □ Four-quadrant drive with converter □ Four-quadrant drive with converter and tacho-voltage feedback with inner current loop □ Single-quadrant drive with converter □ Single-quadrant drive with converter and tacho-voltage feedback with inner current loop **AC SLIP-RING MOTOR DRIVE** □ Control of stator voltage with transformer □ Control of stator voltage with controller □ Control of stator voltage and tacho-voltage feedback □ Rotor starter □ Rotor pulsed resistor						

			□ Rotor pulsed resistor and tacho-voltage feedback □Scherbius static drive □Scherbius static drive and tacho-voltage feedback **AC SQUIRREL CAGE MOTOR DRIVE** □ Preliminary investigation of the squirrel cage motor □ Six-pulse PAM □ Pulsed square-wave triggering □ Trapezoidal modulation □ Pulse width modulation (PWM) □ Voltage vector control (VVC) □ Motor magnetization for linear U/f characteristic □ Extra start magnetization □IxR compensation □ Operation in standard converter setting □ Slip compensation □ Motor operation in star connection □ Brake chopper □ Speed control with tacho-voltage feedback						

Firm Name: _____
Signature: _____
Name: _____
Designation: _____

Annex A-1

Special Instructions

Description	Bidder		
	Yes	**No**	**Alternate Offer**
Environment Conditions (a) Temperature range: 05^{o}C to +60^{o}C (b) Relative humidity: 0-70% non-condensing			
Warranty period Two years from the date of commissioning. A warranty sticker is to be pasted on each imported item by the Supplier / OEM highlighting Name of Firm, Contract No and date, Description of Store and Warranty validity			
Training Notes Supplier will provide a set of handouts for training on operation and maintenance of the equipment			
Publications Supplier is to provide hard and soft copies (CD) of following manuals. (a) **Operational / Maintenance manual**: - Qty 01 with Equipment and additional Qty 02 for record purposes and should consist of following sections:- (1)**Equipment Description /Operation**:- (a)Specifications (b)Description (c)Operation (2)**Servicing**:- (a) Maintenance Schedule (b) Adjustment / test (c) Removal / Installation procedure (d) Tools Used (3) Trouble shooting guide (4) Cleaning requirements (5) Shipping and receiving (6) Storage requirements (b) **IPB** (Illustrated Parts Breakdown Manual) should have full parts description along with detailed diagrams (exploded view).			

(c) **Experimental manuals** which must contain the list and procedure of the experiments that equipment can perform.			
Spares / Technical Support (a) Supplier to have in-country spares / technical support and ensure spares and technical support / assistance for next 10 years (b) Comprehensive list of spares required for scheduled maintenance of Equipment is to be provided (c) Any software provided must have its license (d) Software upgrade support must be provided free of cost for 10 x years with renewed license at every upgrade (e) Supplier must also provide calibration service for at least 5 x years after commissioning			
Additional Spare / Replaceable parts. (a) Replaceable spare / parts during scheduled inspections are to be identified and provided as per requirement along with equipment sufficient to cater five years consumption. (b) All specialized / standard tools required for inspection / repair / servicing must be supplied along with equipment.			
Physical Inspection Criteria: 100% physical inspection of store will be carried out before commissioning of the equipment for following details:- (a) For physical damage, scratches and deformity. (b) Accessories /components as per contractual specifications. (c) Technical Manuals (Operation manual, user guide, IPBs). (d) Quality certificate and calibration certificate by the OEM (e) OEM certificate and verifiable documents by the supplier that store has been procured from certified source and is factory new and from latest production. (f) Brand name and country of origin.			
Commissioning (a) Commissioning of the equipment will be carried out 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: Foreign Training Required: Factory acceptance test and 5 days training for two nominated faculty members before shipment at OEM expense (boding, lodging and travelling expenses).			

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

Firm Name_____
Signature_____
Name_____
Designation_____

Annex-B

TECHNICAL OFFER

NUTECH / SCM / Electrical Lab Eqpt (PSDP) 2020 / TD-110

Fill in following essential parameters:-

1. Validity of Offer: _____Days (Should not be less than **90 days**)
2. Delivery period: _____Days (after placement of order)
3. Country of Origin: _____
4. Warranty Period: _____

General

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

Payment Terms (through LC)

1. 80 % through LC on sight.
3. 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

SCHEDULE TO TENDER

Ser	Part No	Item Name/Size	Specification	A/U	Qty Req	Price Per Unit (USD)	Total Price (USD)
1		**Electrical Machines Trainer**	**Electrical Machine Trainer comprising the following modules as per quantity mentioned against each:** **(a) Complete Electrical Machines Training Systems (Qty-3)** **(b) Open Lab Electrical Machines Training Systems (Qty-2)** **Total Qty (Req) = 3+2= 5**	No	5 (3+2)		
	a	**Module (a)**	**Complete Electrical Machines Training Systems with following Equipment**				
	a(i)	**Motor Driven Power Supply**	**Motor Driven General Purpose Power Supply (Programmable)** • Suitable for fixed/Variable ac and dc current. • Emergency Mushroom head. Over speeds Protection. • Variable ac: 3x0÷380V, 2A & 3x0÷240V, 3A • Fixed ac: 3x380V +N, 10A, 3x220V, 3A • Variable dc: 0÷240V, 4A, 0÷225V, 1A • Fixed dc: 220V, 4A • Power Supply: 3x380V+N, 50/60Hz				
	a(ii)	**DC Machines**	**DC Machines-1:** **Direct Current Generator** **Series, Shunt and Compound Excitation** It can be used as a motor 2800 r.p.m. Voltage: 220V Current: 1.18A Excitation: 190V/0.1A **DC Machines-2:** **Direct Current Motor** **Series, Shunt and Compound Excitation** It can be used as a Generator				

			Power: 260W. Speed: 2800 r.p.m. Voltage: 220V Current: 1.18A Excitation: 190V/0.1A				
	a(iii)	**Three Phase AC Motors**	**<u>Three Phase AC Motors-1:</u>** **Squirrel Cage Three-Phase Asynchronous Motor** Power: 370W. Speed: 2650 r.p.m. (50Hz), Connections: Star/triangle. Voltage: 220/380V Δ/Y Current: 2/1.1A Δ/Y. **<u>Three Phase AC Motors-2:</u>** **Three- Phase Wound Rotor Asynchronous Motor** Power: 370W. Speed: 2650 r.p.m. (50Hz), Connections: Star/triangle. Voltage: 220/380V Δ/Y Current: 2/1.1A Δ/Y.				
	a(iv)	**Single Phase AC Motors**	**<u>Single Phase AC Motors-1:</u>** **Capacitor Motor** Power: 370W Speed: 2720 r.p.m. Frequency: 50Hz. Voltage: 220 V, Current: 3A **<u>Single Phase AC Motors-2:</u>** **Universal Motor** Speed: 3000 r.p.m. Frequency: 50Hz. Voltage: 220 Vac/220Vdc. Current: 3.5Aac/3Adc **<u>Single Phase AC Motors-2:</u>** **Repulsion Motor** Speed: 3000 r.p.m. Frequency: 50Hz. Voltage: 220 Vac/220Vdc. Current: 3.5Aac/3Adc				
	a(v)	**Single Phase Transformer**	**Single Phase Transformer** Corer type transformer with split windings. Power Rated: 300VA Primary Voltage: 127/220/380V Secondary Voltage: 2 x 110V It is also used as an Auto-Transformer				

	a(vi)	**Three Phase Transformer**	**Three Phase Transformer:** Column-type transformer with split windings. Power Rated: 300VA Primary Voltage: 2 x 110V (Phase) Secondary Voltage: 2 x 110V (Phase) It is also used as a Single-Phase Transformer				
	a(vii)	**Measuring Modules**	**Electrical Power Digital Measurement Unit:** DC Voltage: 500V AC Voltage: 500V DC Current: 9.9A AC Current: 9.9A Power: 600W **Mechanical Power Digital Measurement Unit:** Torque: 0 ÷ 1.999 Nm; Speed: 6000 rpm Power: 600W Dc Output: 0 ÷ 220V, 0.6A Power Supply: 220V, 50/60Hz				
	a(viii)	**Load Cell**	**Load Cell:** Resistance electronic strain-gauge 150N Range, to be mounted on the braking system to measure the mechanical torque.				
	a(ix)	**Braking Assemblies:**	**Eddy-Current Brake (Electromagnetic Brake)** Smooth roll and salient pole stator Speed: 5000 rpm Power: 450W Power Supply: 250Vdc				
	a(x)	**Power Supply for Break**	**Power Supply for Breaking Systems:** Output: 0÷120V, 2 A or 0÷220V, 1 A. Power supply: single-phase from mains				
	a(xi)	**Universal Base**	**Universal Base for Motors:** Anti-vibration rubber feet, fixing of two machines and with coupling guard and locking of the rotor of the slip-ring Asynchronous machines.				
	a(xii)	**Connecting Leads**	Connected Leads				

	a(xiii)	**Loads and Accessories**	**Capacitive Load:** Single Phase or Three Phases Capacitive step-variable Load Power: 3 x 105VAr Voltage: 220/380V Δ/Y. **Inductive Load:** Single Phase or Three Phase Capacitive step-variable Load Power: 3 x 100VAr Voltage: 220/380V Δ/Y **Resistive Load:** Single Phase or Three Phase Capacitive step-variable Load Power: 3 x 110W Voltage: 220/380V Δ/Y.				
	a(xiv)	**Accessories**	Starting Rheostat, Excitation Rheostat, Star/Delta Starter, Pole Switching Unit, Other accessories which will be useful in trainer				
	b	**Module (b)**	**Open Lab Electrical Machines Training Systems with following Equipments**				
	b(i)	**SET OF COMPONENTS**	It includes the following components: Base plate Supports with bearing Coupling joints Flexible coupling Electronic speed transducer Assembling screws Wrenches DC stator AC stator Rotor with commutator Brush holder with 2 brushes Cage rotor Ring rotor Brush holder with 6 brushes **The short description of the above given below:**				

			This system is a complete set of components and modules suitable for assembling the rotating electric machines, both for direct current and for alternating current. Besides, a magnetic probe is foreseen to display the magnetic fields and a transparent covering, for safety reasons, prevent students from the accidental contact with the rotating parts. The **AC STATOR** is composed of a metal frame supporting the laminated magnetic circuit, because interested by a flux variable in time, and the electrical winding. The sheet iron pack is 60 mm long, with internal diameter of 80 mm and external one of 150 mm and it presents 24 half-closed slots inside of which there is a double three-phase winding: the beginnings and the ends of the different phases are shown outside the stator on a suitable educational terminal board. The winding is a double layer one of the long coil lap type, with winding span 6 (1÷7). Every slot contains two coils of 19 turns each of enameled wire of diameter 1.12 mm. The **SQUIRREL CAGE ROTOR** is composed of a shaft to which a pack of magnetic sheet irons is fixed, where the slots suitable to contain the rotor winding are set. The sheet iron pack is 60 mm long, with external diameter of about 78 mm. To avoid the phenomenon of the motor crawling in starting phase and to reduce the noise, the slots are inclined as regards the stator ones. The rotor winding is composed of the squirrel cage. The cage is carried out by setting in every rotor slot some conducting bars that are closed in short-circuit at both ends by means of some conducting rings. The rotor winding can be therefore considered a multi-phase winding, with a single conductor for pole- phase, so it does not present its proper pole number but it assumes one that is equal to the stator winding one. The **RING ROTOR** is composed of a shaft to which the collector rings and a magnetic sheet iron pack are fixed: the iron pack has 21 semi-closed slots suitable to contain the winding. The sheet iron pack is 60 mm long, with external diameter of about 78 mm. To avoid a noisy mechanical running the rotor slots are				

			inclined as regards the stator ones. The rotor winding is composed of coils and it is two pole three-phase. The winding is a double layer one of the long coil lap type, with winding span 9 (1-10). Every slot contains two coils of 8 turns each of enameled wire of diameter 1.5 mm. The winding is star connected and it is subordinate to the collector rings while the star centre is internal and not accessible. The terminals of the rotor winding are accessible by means of the collector rings on which the bushes supported by a brush holder graze. The brushes are two for each phase and they are subordinate to an external terminal board that shows the synoptic of the rotor winding. The **DC STATOR** is composed of a metal frame supporting the laminated magnetic circuit, with 2 main poles and 2 inter poles, and the electrical windings. The sheet iron pack is 60 mm long, with internal diameter of 80 mm. On the poles the coils are wound whose terminals are shown on a suitable educational terminal board. The **DC ROTOR** is composed of a shaft to which the segment commutator is fixed and of a magnetic sheet iron pack where 20 semi-closed slots suitable to contain the electrical winding are set. The sheet iron pack is 60 mm long, with external diameter of about 80 mm. The winding is a double layer one of the long coil lap type, with winding span 9 (1÷10). Every slot contains two coils with two sections of 5+5 turns carried out with enameled wire of diameter 1.12 mm. The winding is subordinate to the 40 segments of the commutator on which two brushes are supported by a brush holder graze. The brushes are subordinate to terminals set on two external boards that show the synoptic of the rotor winding.				
	b(ii)	**POWER SUPPLY**	POWER SUPPLY Outputs in ac: • Three-phase: 24 V/14 A, 42V/10A • Single-phase: 0 – 48 V/5 A, 0 – 10 V/12A Outputs in dc: • 32 V/14 A, 42 V/10 A, 0 – 40 V/5 A, 0 – 8 V/12 A Three-phase power supply from mains. Complete with over-speed protection				

	b(iii)	**ELECTRIC AND SPEED MEASUREMENT**	Power supply: 100-240 Vac 50/60 Hz •Vac/Vdc measurement range: 0-65V •Iac/Idc measurement range: 0-20A • Speed measurement range: 0- 4000 rpm at 50Hz • 0-6000 rpm at 60Hz Communication: Modbus RTU RS485 • Encoder resolution: 5 pulses / revolution				
	b(iv)	**LOADS AND RHEOSTAT**	resistors: • 3x15 Ohm, 90 W each, 1 Ohm + (0 - 2 Ohm), 80 W capacitors: 3 x 80 µF, 150 V • rheostat: 0 - 80 Ohm, 1 A				
	b(v)	**ADAPTER BRACKET**	Necessary for connecting the locking device, the brake or the drive motor.				
	b(vi)	**LOCKING AND ROTATING**	Suitable for locking and rotating the rotor of slip- ring induction motors to obtain an induction regulator and phase transformer				
	b(vii)	**POLE CHANGING**	Switch to change the number of poles on motors.				
	b(viii)	**PARALLEL BOARD**	Rotating light synchronoscope to perform the parallel connection between synchronous generators or between the alternator and the mains.				
	b(ix)	**ELECTROMAGNETIC BRAKE&STAR/DELTA STARTER**	Smooth roll rotor and salient pole stator For three-phase squirrel cage induction motors.				
	b(x)	**STARTING AND SYNCHRONIZATION**	Rotor starter for three-phase slip ring motors and excitation device for synchronization with the mains.				
	b(xi)	**FAULT SIMULATORS**	Set of 4 masks to insert simulated faults in the machines of the OPENLAB system. The set includes: • FAULT SIMULATOR FOR A THREE-PHASE CAGE MOTOR - Short-circuit between two phases - Break-up of a stator phase - Break-up of two phases - Internal short-circuit				

			• FAULT SIMULATOR FOR A SLIP RING MOTOR - Short-circuit between two phases - Break-up of a stator phase - Internal short-circuit • FAULT SIMULATOR FOR A SINGLE-PHASE CAPACITOR MOTOR - Unsuccessful starting of the motor • FAULT SIMULATOR FOR A COMPOUND EXCITED DC MOTOR - Unsuccessful starting of the motor - Break-up of a stator phase - Shunt excitation circuit reversal				
	b(xii)	**Accessories**	Starting Rheostat, Excitation Rheostat, Star/Delta Starter, Pole Switching Unit, Other accessories which will be useful in trainer				
			Experimental Capabilities Flux produced by the poles Main magnetic field Intensity of the magnetic field Induced voltage Inter pole effect No-load magnetic neutral axis Rotating magnetic field 3-phase squirrel cage motor, 2 poles, 24 VΔ 3-phase squirrel cage motor, 2 poles, 42 VY 3-phase squirrel cage motor, 2 poles, 24 VΔΔ 3-phase squirrel cage motor, 2 poles, 42 VYY 3-phase squirrel cage motor, 4 poles, 24 VΔ 3-phase squirrel cage motor, 4 poles, 42 VY 3-phase motor, 4/2 poles, 42 VΔ/YY Split phase motor Capacitor start and run motor 3-phase motor with wound rotor, 2 poles, 42 VYY Phase shifter Induction regulator 3-phase synchronous induction motor, 2 poles, 24 VΔ 3-phase synchronous induction motor, 2 poles, 24 VΔΔ				

			DC motor with separate excitation DC motor with shunt excitation DC motor with series excitation DC motor with compound excitation, long shunt DC motor with compound excitation, short shunt Single phase series motor Repulsion motor Synchronous motor winding resistance Synchronous motor no-load test Synchronous motor short-circuit characteristics Synchronous motor short-circuit test Synchronous motor Behn-Eschenberg's method Synchronous motor load test Synchronous motor conventional efficiency Parallel connection of the alternator with the mains Alternator as synchronous motor DC generator winding resistance DC generator test of the no-load motor (Swinburne) DC generator no-load e.m.f. DC generator excitation characteristics Separate excitation dynamo Shunt excitation dynamo Series excitation dynamo Compound excitation dynamo				
2.		**Power Electronics Trainer (Complete Package)**	**Selenium rectifier Qty. 1(per unit set)** Rated alternated voltage: 30 Vrms Rated continuous voltage: 24 Vav Rated continuous current: 10 Aav **Silicon diode Qty. 4(per unit)** Direct average current: IFAV = 12 A max. Direct non repetitive overload current: IFSM = 75 A (tp = 10 ms) Repetitive peak reverse voltage: URRM = 1000 V Recovery reverse time: trr = 65 ns max. **Group of diodes Qty. 1(per unit)** Six fast acting silicon diodes with RCD protection	No	2		

			network suitable for realizing non-controlled rectifying circuits. Direct average current: IFAV = 12 A Direct non repetitive overload current: IFSM = 75 A (tp = 10 ms) Repetitive peak reverse voltage: URRM = 1000 V Recovery reverse time: trr = 65 ns max. **SCR Qty. 1(per unit)** Direct average current: ITAV = 7.6 A max. True RMS value of the direct current: ITRMS = 12 A Max. repetitive reverse voltage: URRM = 800 V Trigger current: IGT = 15 mA max. Trigger voltage: **Group of SCR Qty. 2(per unit)** Six silicon controlled rectifiers with RCD protection network used for realizing controlled rectifiers and inverters. Direct average current: ITAV = 7.6 A max. True RMS value of the direct current: ITRMS = 12 A Max. repetitive reverse voltage: URRM = 800 V Trigger current: IGT = 15 mA max. Trigger voltage: UGT = 1.5 V max. I2t = 72 A2s **Triac Qty. 1(per unit)** Bidirectional thyristor used for the control in alternated current. Complete with RC suppressor network. True RMS value of the direct current: ITAV = 8 A max. Non-repetitive peak current: ITSM = 70 A, 50Hz (77A, 60Hz) Max. repetitive reverse voltage: UDRM = 800 V Trigger current: IGT = 25 mA max. (all the quadrants) Trigger voltage: UGT = 2.5 V max. State keeping current: IH = 25 mA max. I2t = 24 A2s **MOSFET Qty. 1(per unit)** N-channel enhancement mode power MOS with integrated reverse diode (FRED, Fast Recovery Epitaxial				

			Diode) used as very fast switch in switching regulators and inverters. Drain-source voltage: UDS = 400 V Continuous drain current: ID = 10 A Drain-source on-state resistance: RDS(on) = 0.55 Ω Gate-source voltage: UGS = +-20 V **IGBT Qty. 2(per unit)** N-channel Insulated Gate Bipolar Transistor (IGBT) with anti parallel hyper fast protection diode used as very fast switch in switching regulators and inverters. Collector-emitter voltage: UCES = 600 V Continuous collector current: Ic=24 A at Tc=25ºC Collector-emitter saturation voltage: UCEsat = 1.8 Vtyp at Ic=15 A Gate-emitter voltage: UGE = ± 20 V **Group of IGBT Qty. 1(per unit)** 4 N-channel Insulated Gate Bipolar Transistors (IGBT) with anti parallel hyper fast protection diode used as very fast switches in switching regulators and inverters. Collector-emitter voltage: UCES = 600 V Continuous collector current: Ic = 24 A at Tc = 25ºC Collector-emitter saturation voltage: UCEsat = 1.8 Vtyp at Ic=15 A Gate-emitter voltage: UGE = ± 20 V **Bridge three phase rectifier Qty. 1(per unit)** Non-controlled three-phase rectifier in six pulse bridge connection B6UK for the generation of a DC voltage from a three phase mains. Rated alternating input voltage: UVN = 400 V Direct output voltage: Ud = 540 V Rated direct current: IdN = 10 A Surge forward current: IFSM = 300 A				

			I2t = 400 A2s Voltage drop: UF = 1 V per diode **SCR with turn off circuit Qty. 1(per unit)** Main SCR and auxiliary SCR, complete with RC uppressor circuit. Direct average current: ITAV = 13 A max. Max. repetitive reverse voltage: UDRM = 800 V tq = 35 ms Block diodes and flywheel, complete with RC suppressor circuit. Max. repetitive reverse voltage: UDRM = 600 V IAV = 8 A Turn off capacitor: C = 2 µF Oscillation coil: L = 1 mH Shunt for the measurement of the currents in each branch: 4 x 0.1 Ω **DC Power Supply Qty. 1(per unit)** Laboratory power supply with two fixed voltage outputs and protected against short-circuit. Output voltages: +15 V ; 0 V ; -15 V Output current: 2,4 A (3 A for a short period) Power supply: single-phase from mains Two led (+15 V ; -15 V) for the indication of the nominal voltage. Mains switch with pilot lamp **Voltage Reference Generator Qty. 1(per unit)** Power supply: +15 V ; 0 V ; -15 V Range of the continuous regulation reference signal: from - 10 V to + 10 V, from 0 to + 10 V Range of the step reference signal: from - 10 V to + 10 V, from 0 to + 10 V Switch for selecting between internal potentiometer reference signal and external reference signal Switch for selecting between the 0 / ±10 V range and the 0 /+10 V range **Trigger point limiter Qty. 1(per unit)** Stability limit for rectifier: 0° to 180° Stability limit for inverter: 180° to 0° Power supply: +15 V / 0 V / - 15 V				

			Two pulse control unit Qty. 1(per unit) Power supply: +15V/ 0V / - 15V (25mA) Synchronization voltage: 1 to 440 V Control voltage Uc: 0 V to 10 V Trigger angle: 180° to 0° Number of outputs: 2 x 2 Possibility of pulse train or single pulse. Possibility of selecting two natural switching points: 0° and 30°. Inhibit voltage: UINH = 15 V (open): trigger pulses. UINH = 0 V: no trigger pulses. **Six pulse control unit Qty. 1(per unit)** Power supply: +15V/0V/- 15V (300mA) Synchronization voltage: 1 to 440 V Analogue control voltage Uc: 0 to 10V Digital TTL control: DWH = FH...FFH (15...255)10 Trigger angle: 180° to 0°(300°...120°/60°...240°) Number of outputs: 3 x 2 Possibility of pulse train or single pulse. Possibility of excluding the secondary pulse. Possibility of selecting three natural switching points: 0°, 30°and 60°. Inhibit voltage: UINH = 15 V (open): trigger pulses. UINH = 0 V: no trigger pulses **PWM, PFM, TPC control unit Qty. 1(per unit)** Power supply: +15V/0V/- 15V (600 mA) Control voltage: Uc: 0 to 10V PWM: 20-200 Hz/0.2-2 kHz/2-20 kHz Duty cycle D = ton/T = 0-0.95 PFM: 5-50 ms/50-500 ms/0.5-5 s Frequency: 20 Hz to 20 kHz TPC: Hysteresis: UH = 0 to 2 V Number of outputs: 2 x 2, with led indication of the status Output amplifier: threshold voltage 5 V, short-circuit proof Inhibit voltage:				

			UINH = 15 V (open): trigger pulses. UINH = 0 V: longer pulses at certain outputs only. **Run-up control unit Qty. 1(per unit)** Power supply: -15 V/0 V/ 15 V Input signal range: Ui = -10 V ... 10 V Fine adjustment of the slew-rate: 0.5 . . . 50 V/s Fine adjustment of the voltage gain: 0.1 . . . 1 Inhibit voltage: UINH = 0 V: zero output voltage U0 and output UINH = 15 V UINH = 15 V (open): output voltage U0 runs up and output UINH =0 V **PID Controller Qty. 1(per unit)** Standard industrial controller that can be used as P, PI, PD or PID controller in the closed loop automatic control systems. Power supply: +15 V ; 0 V ; -15 V Input summing node for two different reference variables UR and UC and for one controlled variable UA. Signal voltage range: -10V .... +10V Parameters of the controller continuously adjustable Proportional gain: Kp = 0 ... 1000 Time of the integral action: TI = 1ms ... 100s Time of the derivative action: TD = 0.2ms ... 20s Reset input of the integral controller. Output summing node to add or subtract noise variables. Measurement terminal for the error signal. Adjustment screw for the output offset. Three led indicator of the sense of deviation. Coarse and fine adjustment of the proportional gain Kp, of the time of the integral action TI and of the time of the derivative action TD. Indicator of over-range: led "over" on when the output voltage is higher than 10 V or lower than -10 V. Input Ioff for resetting the I controller.				

			Absolute value generator Qty. 1(per unit) Power supply: -15 V/0 V/+15 V Input signal range Ui: -10 V . . . + 10 V Adjustable gain: 0 . . . 1 Inverting control input: UINV = 0 V: the input signal is inverted UINV = 15 V or disconnected: the input signal is not inverted Inhibit voltage: UINH = 0 V: the output signal is zero UINH = 15 V (open): the absolute value circuit is active **Adaptive PI controller Qty. 1(per unit)** Double compact PI controller for use as current controller in dc servo drives. Power supply: -15 V/0 V/+15 V Input summing point for two different reference variables UR and UC and one controlled variable UA. Signal voltage range: -10 V . . . + 10 V Continuously adjustable parameters of the two controllers: proportional gain Kp = 0 . . . 1000 integral action time TI = 0.2 ms . . . 20 s Integral element reset by switch or via external signal. Regulator selection by switch or via external signal. **Gain and Offset Adjust Qty. 1(per unit)** Power supply: +15 V ; 0 V ; -15 V Voltage interval of the input signal: -50 V, ..., +50 V Adjustable level through the setting of the gain: 0 ....1, 0 .... 10, 0 .... 100 Attenuation of the pulse signals. Time constants: 0,1 .... 10 ms ; 10 .... 100 ms Offset voltages that can be connected: -10 V .... +10 V Coarse setting through rotary switches. Potentiometer fine setting. **Mains transformers Qty. 1(per unit)** Three-phase transformer able to supply single and three phase voltages				

			as well as a rectified voltage for the excitation of the dc machines. Three pilot lamps for signaling the mains voltage. AC output through isolation transformer: 3 x 90 V/1.5 A with 3 intermediate sockets at 45 Vac. DC output, non isolated from mains: 1 x 220 V/1 A, switch with pilot lamp and magneto-thermal protection 1 A **Capacitors Qty. 1(per unit)** Two electrolytic high performance capacitors. Rated value: 2 x 1000 µF Rated voltage: 385 V Protection against polarity inversion. Discharge resistance: 330 kΩ (t = 330 s) **Super-fast fuses Qty. 2(per unit)** Nominal voltage: 660 Vac Nominal current: 3 x 6.3 A and 3 x 10 A **Switching transformer Qty. 1(per unit)** Ferrite core N27 without air gap. Primary: 2 x 115 V, 2 x 48 turns Thermal protection: 2 x 0.6 A Secondary: 2 x 15 V/ 4.5 A, 2 x 7 turns Inter-winding shield. Rated power: 135 VA Rated frequency: 15 kHz **Current transformer Qty. 1(per unit)** For potential-free measurements of ac currents in single and three-phase without neutral. Current: 10 A Unsmoothed output voltage for synchronization. Smoothed output voltage for current regulator. Transformation ratio: 2 V / 1 A and Insulation voltage: 3 kV **Trigger pulse switch Qty. 1(per unit)** For switching the trigger pulses from the control unit to double converters in 4-quadrant systems. Two pulse inputs and Two control inputs. Eight electrically isolated pulse outputs and Power supply: +15 V				

			Switching logic Qty. 1(per unit) Input Xn for torque comparator (speed set point value). Input Xi for current comparator with adjustable limit threshold. Output SA and SB for the corresponding inputs of the trigger pulse switch with led indication of the active converter. Output INV for the corresponding inverting input of the absolute value generator. Output INH for the corresponding inhibit input of the two pulse control unit, with adjustable delay time from 10 ms to 2 s and led indication of the commutating time. Current comparator output C for EXT selection input of the active elements of the adaptive PI controller. Power supply: +15 V/0 V/-15 V **Function generator Qty. 1(per unit)** Functions: sine / triangle / square wave / square wave with variable duty cycle. Frequency range: 10 Hz . . . 100 kHz in 4 decades. Output voltage: 0 V to 20 Vpp adjustable Two additional outputs with attenuator: -20 dB/ -40 dB TTL output for triggering. VCO input, AC coupled. Power supply: single-phase from mains **Voltage divider 20:1 Qty. 1(per unit)** Electronic voltage divider used as an interface between the dc machines (200 V) and the automatic control circuits (-10 V …+15 V). Possibility of capacitive filter with time constant 0.1 s. Protection against over voltages up to 1000 Vdc. Power supply: +15 V / 0 V / - 15 V **Universal Load Qty. 1 (per unit)** Ohmic, inductive and capacitive load suitable for the experiments in the power electronics laboratory. a) Load resistors: 3 x 100 Ω/1 A and Protection with fuses: 3 x T1.25 A Possibility of connecting in series (300 Ω), in parallel (33.33 Ω) or in star and delta b) Load inductors: 2 x (12.5 - 50) mH/2.5 A				

			Possibility of connecting in series (100 mH) and in parallel (6.25 mH). c) Load capacitors: 4-8-16 μF/450 Vac Possibility of connecting in parallel (28 μF). Discharge resistor: 1 kΩ/0.22 A **Socket with lamps Qty. 1(per unit)** Three lamp-holders E14. Complete with three incandescent lamps: 40 W/220 V. Possibility of connecting in parallel. **Stabilized power supply Qty. 1(per unit)** The power supply has two sections: Regulated variable voltage section, used to supply the armature of dc motors. Output: 0 ÷ 240 Vdc, 5 A Drive: manual or external via 0 ÷ 10 Vdc signal Constant voltage section, used to supply the excitation circuit of dc machines. Output: 220 Vdc, 1 A **Phase control fault simulator Qty. 1(per unit)** Double time-constant standard light dimmer circuit consisting of triac, diac, two control potentiometers, resistors and capacitors. A total of 20 faults can be switched on using switches located behind a cover. Typical faults: interruptions, short-circuit, faulty components and faulty design. Power supply: 110 to 230 V, 47-63 Hz Ohmic load: 1.2 kW max **EMI Filter Qty. 1(per unit)** Inductances on the line: 0.4 mH Capacitors between conductors and neutral: 100 nF Capacitor between neutral and ground: 22 nF **Isolation amplifier Qty. 1(per unit)** Isolation amplifier, channels A, B, C, E: - Frequency range: dc to 80 kHz. - Max Input voltage: Max 620 Vdc/460 Vac Input resistance Ri = 1 MW in all ranges				

			- Input current (between 0 and I) Max: 10 A continuous; 16 A for t< 15 min; 20 A for t<2 min. Internal resistance: 30 mW in all ranges Five outputs: A, B, C, D, E with led for over range Indication Output resistance RO: 100 W - Multiplexer: Mux channels, selectable: 1 to 8 (4 x signal; 4 x zero line) Gain attenuator, adjustable: 0.2 to 1. Y-position, adjustable: -8 V to + 8 V. Mux frequency, adjustable: 50 kHz to 500 kHz (typical). Two BNC outputs for oscilloscope Mathematical module and filter: - Functional modes for channel D: Addition A+B; subtraction AB; multiplication AxB/10 or AxB; reconstruction of the phase voltage LIN(A, B, C) from the line-to line voltages; channel E switched into channel D for multiplexing. - Filter Low pass active filter of the 2° order required for the recovery of the fundamental wave out of the PWM signals. Cut-off frequency: 1 kHz. Space vector indicator: - Voltage vector: indication with 7 led. - Magnetic flux vector: BNC outputs X e Y for oscilloscope. Power supply: - Single-phase from mains Frequency: 50/60 Hz. Support with 3 shunts 1 ohm Support with 3 shunts, with different connection possibilities. Resistance: 1 Ω ; Accuracy: ± 1% ; Max. current: 2.5 A **Support with 3 shunts 0.1 ohm Qty. 1(per unit)** Support with 3 shunts, with different connection possibilities. Resistance: 0.1 Ω ; Accuracy: ± 1% ; Max. current: 8 A **Frequency converter Qty. 1(per unit)** Transistor pulse-converter with pulse driven voltage source inverter and transistor for the generation of a three-phase, variable frequency and variable voltage				

			system. In conjunction with the PWM control unit this device is used for the realization of a frequency converter for asynchronous motor drive. Output voltage: 3 x 0...230 V Output current: 3 x 8 A max. Supply voltages: power circuit, 1 x 255 V max, 50/60 Hz control circuit, single-phase from mains **PWM Control Unit Qty. 1(per unit)** Control unit used in conjunction with the frequency converter to build a voltage-source inverter which operates with PWM control. All of the control, monitoring and measuring functions are integrated into the control unit while the frequency converter contains solely the power components. A PWM modulator controls the power transistors of the inverter and thus generates a sine-shaped motor current. Modulation possibilities: PWM, VVC, trapezium shaped and block type. **PC Interface Qty. 1 (per unit)** IN/OUT connector for connection to the control unit and display for the visualization in hexadecimal of the control word. Two AO lines for analogue outputs: ±10 V. Six AI lines for analogue inputs: ±10 V The analogue signal is obtained from a D/A converter with 12 bit resolution. Auxiliary relay with led to show the switching status. USB connection. **Power Electronics Software Qty. 1(per unit)** With this software it is possible to measure the wave forms for voltage and current that can be found in the static inverter and converter circuits. Through a microprocessor based interface it is possible to detect the wave forms and to send the controls to obtain trigger angles through software.				

			On the screen the true RMS value, the mean value, the power and other parameters are calculated in order to allow the evaluation of the efficiency of the different circuits. The software features a very accurate graphic presentation and a user friendly interface with the end user. **Induction Motor Control Software Qty. 1(per unit)** With this software it is possible to realize the PWM, VVC, trapezium shaped and block type, full and half frequency control of the frequency converter and to do the acquisition of the mechanical characteristics of the induction motor under testing. Voltages, currents and other main characteristics are calculated both in numbers and as curves. The software features a very accurate graphic presentation and a user friendly interface with the end user. **Variable Three Phase Transformer Qty. 1(per unit)** Power supply: three-phase from mains Rated output: 550 VA Secondary phase current: 1.25 A Secondary voltage: 0 to 440 V The voltage is set by means of a variable autotransformer with rotary knob and the output is floating by means of an isolating transformer with subdivided secondary winding. Fitted with mains lamp and motor circuit breaker. **Battery stack Qty. 1(per unit)** Two rechargeable batteries, maintenance free and Capacity: 1.8 Ah/12 V **Tachometer Qty. 1(per unit)** Speed ranges: 1500/3000/6000 rpm Accuracy class: 1.5 Output voltage: 1 V/1000 rpm **Single phase supply unit Qty. 1(per unit)** Power supply: single-phase from mains Cam operated 2-pole mains switch 16 A Automatic circuit breaker: 10 A, operated by thermal effect				

			Output terminals L and N, with pilot lamp Pilot lamp for indication of mains false polarity **Three phase supply unit Qty. 1(per unit)** Power supply unit for three-phase connection with 4-pole cam mains switch. 25 A current operated earth leakage circuit breaker, sensitivity 30 mA. Triple-pole motor protection switch: 6.3 to 10 A. Three-phase indicator lamps. Output through 5 safety terminals: L1, L2, L3, N and PE. **Digital AC/DC Multi-range Power meter Qty. 1(per unit)** • Automatic Scaling • Current range: 0-20 Iac/dc 20 - 100Hz • Voltage range: 0-750 Vac/dc 20 - 100Hz • Power range: 0-1000W, VAR and VA • Accuracy: +/- 0.5% • Resolution: 16bits • Refresh rate : 0.5s • Power supply: 90-260 Vac 50/60Hz • Power consumption: 3 VA • Communication: Modbus (RS485) **True rms meter Qty. 2(per unit)** Voltage: 0 .. 1000V DC 0 .. 1000VACpp 0 .. 750VACrms Current: 0 .. 20 A Continuous overload protection in all ranges. **Moving iron voltmeter Qty. 1(per unit)** Scale: 50 divisions Range: 125-250-500 V Range changeover switch. **Moving coil ammeter Qty. 1(per unit)** Scale: 50 divisions and Range: 2.5 A **Asynchronous squirrel cage three phase motor**			

			Qty. 1(per unit) Squirrel cage three-phase asynchronous induction motor, with three-phase stator winding and squirrel cage buried in the rotor. Rated power: 180 W and Voltage: 380/690 V Δ/Y **Slip ring three phase asynchronous motor** **Qty. 1(per unit)** Induction motor with both stator and rotor three-phase windings. Power: 250 W ; Voltage: 220/380 V D/Y ; Current: 1.65/0.95 A D/Y Excitation: 92 V, 2 A ; Frequency: 50 Hz ; Cosφ: 0.66 Speed: 1350 rpm and Thermal protection. **Rheostatic rotor Qty. 1(per unit)** Steps operated starter for three phase induction motor with slip ring rotor. Step resistance value: 3 x (12-6-3-1-0) W Current: 3 x 2.5 A max. Shunt excitation direct current motor Power: 200 W ; Voltage: 220 V ; Current: 1.5 A Excitation: 200 V, 0.067 A ; Speed: 3000 rpm Thermal protection. **Shunt excitation direct current motor Qty. 1(per unit)** Power: 160 W ; Voltage: 220 V ; Current: 0.73 A Excitation: 220V, 0.075A ; Speed: 2850 rpm Thermal protection **Shunt excitation direct current generator** **Qty. 1(per unit)** Power: 160 W ; Voltage: 220 V ; Current: 0.73 A Excitation: 220V, 0.075A ; Speed: 2850 rpm Thermal protection. **Powder brake Qty. 1 (per unit)** Maximum braking torque: 12 Nm Power: 400 W ; Voltage: 0 ÷ 24 V Speed: 4000 rpm max. and Thermal protection. **Load cell Qty. 1(per unit)** Resistance electronic strain-gauge with 100 N range, to				

			be mounted on the brake unit for measuring the mechanical torque. **Powder brake control unit Qty. 1(per unit)** Speed section: - K2 connector for the speed transducer - Circular scale three-range instrument: 1500/3000/6000 rpm - Analogue output: 1 mV/rpm Torque section - K connector for the torque transducer - Circular scale three-range instrument: 1.5/3/10 Nm - Analogue output: 1 V/Nm Brake control - Output power: 0 to 12 Vdc, 0.5 A - Manual, external or automatic regulation. Thermal protection with alarm indication and Recorder pen control. **Base Qty. 1(per unit)** Metallic structure, fire varnished, suitable for mounting the machine or the group under test. Complete with optical transducer for rotating speed detection and with anti-vibration rubber feet. **Flywheel Qty. 1(per unit)** Used in deceleration tests on rotating machines for calculation of Mechanical iron and copper losses at different excitations. **Stop clock Qty. 1(per unit)** Stopwatch with LCD display. Measuring range: 9 h, 59 min, 59 s, 99/100 s and Battery: 1.5 V **Frame Qty. 2(per unit)** Metal frame for assembling the modules of the laboratory. **Connecting leads Qty. 1(per unit)** Set of connecting leads of different diameters and lengths**.** **Storage Cabinet Qty. 1(per unit)** **<u>Experimental Capabilities</u>**				

			ALTERNATE CURRENT - DIRECT CURRENT CONVERSION (RECTIFIERS) **DIODES AND UNCONTROLLED RECTIFIERS** • Single pulse rectifier, ohmic load • Single pulse rectifier, ohmic-inductive load • Two-pulse rectifier, ohmic load • Two-pulse rectifier, ohmic-inductive load • Two-pulse bridge rectifier, ohmic load • Two-pulse bridge rectifier, ohmic-inductive load • Three-pulse rectifier, ohmic load • Three-pulse rectifier, ohmic-inductive load • Six-pulse rectifier, ohmic load • Six-pulse rectifier, ohmic-inductive load • Six-pulse bridge rectifier, ohmic load • Six-pulse bridge rectifier, ohmic-inductive load **SCR AND CONTROLLED RECTIFIERS** Single pulse converters • Single pulse converter, ohmic load • Single pulse converter, inductive load • Single pulse converter, ohmic-inductive load • Single pulse converter, ohmic-inductive load and free-wheeling diode • Single pulse converter, ohmic-inductive load and back e.m.f. • Single pulse rectifier, ohmic-capacitive load • Single pulse converter, ohmic-capacitive load Two-pulse midpoint converters • Two-pulse midpoint converter, ohmic load • Two-pulse midpoint converter, ohmic-inductive load Multi-phase converters • Three-pulse midpoint converter, ohmic load • Three-pulse midpoint converter, ohmic-inductive load • Six-pulse midpoint converter, ohmic load • Six-pulse midpoint converter, ohmic-inductive load Drainage-coil converters				

			• Double three-pulse star converter, ohmic load Bridge converters • Half-controlled bridge, ohmic load • Half-controlled bridge, ohmic-inductive load • Half-controlled bridge, ohmic load • Half-controlled bridge, ohmic-inductive load • Fully-controlled bridge, ohmic load • Fully-controlled bridge, ohmic-inductive load • Fully-controlled bridge, ohmic load and back e.m.f. • Fully-controlled bridge, dc motor load • Fully-controlled bridge, ohmic load and supplementary dc voltage • Fully-controlled bridge, dc generator load • Three-phase half-controlled bridge, ohmic load • Three-phase fully-controlled bridge, ohmic load • Three-phase fully-controlled bridge, ohmic-inductive load **THYRISTORS & CONTROLLED AC/AC CONVERTERS** **Single-phase controllers** Single-phase ac controller, ohmic load Single-phase ac controller, inductive load Single-phase ac controller, ohmic-inductive load Single-phase ac controller, ohmic load Single-phase ac controller, ohmic-inductive load Half-controlled single-phase controller, ohmic load **Three-phase controllers** Fully controlled three-phase controller, star ohmic load without neutral Fully controlled three-phase controller, star ohmic load without neutral Three-phase controller, star ohmic load without neutral **LIGHT DIMMER FAULT SIMULATOR** Double time-constant standard light dimmer circuit consisting of triac, diac, two control, potentiometers, resistors and capacitors. Examples of exercises: • Fault-free dimmer • DIAC shorted				

			• DIAC with high resistance • The gate of TRIAC works like a diode • Control circuit break • Assembly or component fault • Trimmer shorted • Auxiliary RC circuit not included • Variable resistance R shorted • TRIAC shorted **DIRECT CURRENT to DIRECT CURRENT CONVERSION(CHOPPERS)** Main SCR MOSFET IGBT Step-down converter with SCR with turn-off circuit. PWM control. Step-down converter with IGBT. PWM control. Speed control of a dc motor Step-down converter with MOSFET. PWM control. Step-down converter with MOSFET. PFM control. Step-down converter with MOSFET. TPC control . Step-up converter with IGBT. PWM control. Step-up converter with IGBT. TPC control. Inverting converter with IGBT. PWM control. **SWITCHABLE POWER SUPPLY** Flyback converter with IGBT. PWM control. Forward converter with IGBT. PWM control. Asymmetric half-bridge forward converter with IGBT. PWM control. **DIRECT CURRENT - ALTERNATE CURRENT CONVERSION INVERTERS** Single-phase full-bridge dc chopper. PWM control. Single-phase full-bridge inverter. Square-wave PWM control. Single-phase full-bridge inverter. Sinusoidal PWM control. **FREQUENCY CONVERTERS** Frequency converter Input controlled rectifier				

			□ Output power inverter **MOTOR DRIVES** **DC MOTOR DRIVE** □ Single-quadrant drive with converter □ Single-quadrant drive with converter and armature voltage feedback □ Single-quadrant drive with converter and armature voltage feedback with RI compensation □ Single-quadrant drive with converter and tacho-voltage feedback □ Single-quadrant drive with converter and tacho-voltage feedback with inner current loop □ Two-quadrant drive (I-IV) with converter □ Two-quadrant drive (I-III) with converter □ Two-quadrant drive (I-III) with converter and tacho-voltage feedback with inner current loop □ Four-quadrant drive with converter □ Four-quadrant drive with converter and tacho-voltage feedback with inner current loop □ Single-quadrant drive with converter □ Single-quadrant drive with converter and tacho-voltage feedback with inner current loop **AC SLIP-RING MOTOR DRIVE** □ Control of stator voltage with transformer □ Control of stator voltage with controller □ Control of stator voltage and tacho-voltage feedback □ Rotor starter □ Rotor pulsed resistor □ Rotor pulsed resistor and tacho-voltage feedback □Scherbius static drive □Scherbius static drive and tacho-voltage feedback **AC SQUIRREL CAGE MOTOR DRIVE** □ Preliminary investigation of the squirrel cage motor □ Six-pulse PAM □ Pulsed square-wave triggering □ Trapezoidal modulation				

			□ Pulse width modulation (PWM) □ Voltage vector control (VVC) □ Motor magnetization for linear U/f characteristic □ Extra start magnetization □IxR compensation □ Operation in standard converter setting □ Slip compensation □ Motor operation in star connection □ Brake chopper □ Speed control with tacho-voltage feedback				
Total Amount							

If applicable:

Excises Duty @ _____%

Sales Tax@_____%

Surcharge@_____%

Any other Tax _____%

Note:

1. Quotation will be submitted on CPT basis..

2. Equipment shall be supplied and installed at the premises of the NUTECH. 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.

3. Required price will be indicated in USD (in case quoted price are in different currencies then for sake of comparison ,these will be converted into Pak Currency at rate prevailing on opening day of commercial offer).

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 commercial 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 Tender)

(Capacity in which signing)

Address

Date:

Signature of Witness_

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

CHECK LIST

(This checked list must be attached with your technical offer, duly filled and Signed by authorized signatory)

Tender No_____ **Date**_____

1	a. Tender processing fee ref no_____ b. Bank_____ c. Amount_____	
2	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