EQUIPMENT FOR CONTROL ENGINEERING LABORATORY

1)ON/OFF TEMPERATURE CONTROLLER (INDICATOR CUM CONTROLLER) (CE-1)

Using temp. Sensor RTD PT 100

1) Range: 0 to 200 degree centigrade.
2) Mode of control: on/off
3) Relay: O/E/N make 5 Amp rating
4) Optional: Recorder
5) Set up comes with digital temp. indication, set point indication, set point control and calibration check up for 0 degrees and 100 degree centigrade.

Model size: 192*96*300 mm with powder coated M. S. box having neatly labeled anodized plate.

6) Accuracy of indication: +/- 1% of the full range.

Complete set up with model process heated with comptalux bulbs. A detailed manual.

2) D. C. POSITION SERVOMECHANISM DEMONSTRATION. (CE-2) Will include:

1) 5k-ohm +/- 1-% linearity, Precision servo Potentiometers having bearings used as error detector.
2) Output potentiometer, similar as input potentiometer to convert output position into a voltage signal
3) Summing amplifier with adjustable gain.
4) Armature controlled D. C. servomotor with suitable coupling

required for

i)output position indicator and
ii)Tachogenerator.

5) D.C. tachogenerator coupled to d. c. motor,
for derivative feedback.
6) Preamplifier and power amplifier to drive the D.C. motor
7) on the basis of the error signal. D.C. motor is 12 volt, lamp, permanent magnet a with gear train.
8) Power supply for armature winding and electronic amplifier, suitable test points brought on the side panel.
9) A detailed instruction will be supplied.

3) D. C. MOTOR SPEED CONTROL DEMONSTRATION / TRAINER UNIT. (CE-3)

A: Basic closed loop control for speed using proportional controller and tacho feedback.

1) Potentiometer as input transducer for converting reference speed to reference voltage. It will be suitably marked.
2) D.C. tacho generator / speed sensor will also used to indicate the motor speed in RPM.
3) Summing amplifier to receive inputs, reference signal and tachogenerator output. This amplifier will have an adjustable gain.
4) Separately excited D.C.motor rated for 1500 RPM 1 HP at 220 volts with loading arrangement.
5) Thyristor converter using single phase half controlled converter to control D.C. motor through armature and power supply for field winding and electronic amplifiers.
6) The unit will supplied alongwith instruction manual.
7) The entire system will, for the range 300 RPM to 1000 RPM, work as a closed loop control system.
8) Suitable protection for the electronic circuits and motor.
9) Dimensions of the controller: 64*25*25 cms.

B: USING D. C. MOTOR IN PART (A) ABOVE AND RPM INDICATOR, WE SUPPLY AN INDUSTRIAL VERSION FOR PID CONTROL OF SPEED WITH SEPARATE AMMETER, OVERCURRENT PROTECTION IN A POWDER COATED MS BOX WITH DIMENSIONS: 192*192*300 MM.
(OPTIONAL: AT EXTRA COST)

4) A.C. SERVO SPEED TORQUE CHARACTERICS MEASUREMENT UNIT.(CE-4) Will include:
1.Two-phase servomotor.
2.The speed measuring device which will not load the motor.
A photoelectric pick up using disc with 20 holes and a phototransistor are used for speed sensing. Calibration source at 100 Hz is used for RPM indicator .
3.Loading arrangement for servomotor.
4.Torque measuring device.
5.A detailed instruction manual.RPM indicator and ammeter measuring load current.
6.Unit will be covered by an acrylic sheet to facilitate clear view of the entire system.
Dimension: 50*38*22 cms. The a.c. servomotor is having its reference winding at 110 volts with the control windingoperating at 60 volts maximum. The maximum torque is typically 70 gm-cms.

5.D.C. VOLTAGE REGULATOR AS A CLOSED LOOP SYSTEM. (CE-5)
This set up facilitates detailed study of simple series regulator system.Features:
1) In built three and half digit voltmeter with ranges: 0 to 2 volts, 0 to 20 volts, 0 to 200 volts.
1) Facility to vary incoming line voltage by using transformer tapings at 14 volts, 18 volts and 22 volts. This is done by using patch cords and binding terminals.
2) Both line regulation and load regulation can be calculated.
3) Variation of loop gain and its effect on the regulation can be studied. The system comes in two parts; Part A & Part B.Part A houses digital voltmeter and unregulated power supply with dimensions 28.5*19.5*19.5 cms. With neatly labeled anodized front plate. Part B houses regulated power supply, ammeter, loading resistance with elegant anodized plate.

6.SYNCHRO TRANSMITTER RECEIVER PAIR. (CE-6)
This set up is designed to demonstrate the working of a synchro (torque) transmitter with the help of a synchro receiver. Features:
1) The input angular displacement displayed on anodized dial.
2) The output angular displacement displayed on anodized dial.
3) Two rotor terminals (R1 & R2) three stator terminals (S1, S2 and S3) are brought out on the front panel.
4) Detailed instruction manual.

The system can be studied in two parts:
A: study of synchro only, which demonstrates how a given angular position is converted into a unique set of stator voltages.B: interconnection of synchro transmitter and receiver pair demonstrates working og the set up as a torque transmitter.Dimensions: 54*18*20 cms.
We can also supply a set up as SYNCHRO TRANSMITTER AND CONTROL TRANSFORMER. This set up demonstrates how an error voltage is generated at the rotor terminals of control transformer in response to angular misalignment between rotors of synchro transmitter and control transformer.
Dimensions: 54*18*20 cms.

7.STUDY OF SIMPLE THERMAL SYSTEM (STIRRED TANK MODEL). (CE-7)

This system makes use of a stirred tank of **1-liter** capacity as a model process. The tank is provided with water inlet and outlet connections. The tank is well insulated **and is fitted with motor and associated stirrer** for getting a uniform process temperature.

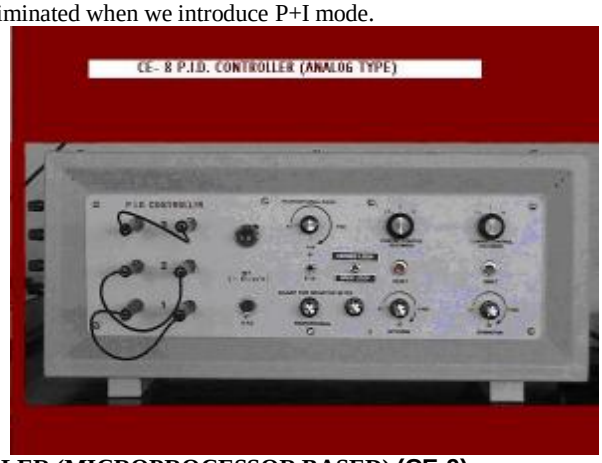
8) P.I.D. CONTROLLER (ANALOG TYPE.) (CE-8)

Description: the PID controller is designed to demonstrate the basic principles of Proportional, Integral and Derivative control action with the help of a model process where in temperature is controlled.

The PT-100 RTD is used to monitor the process temperature. The unit has following features.

1) Modular construction for PID action.
2) Proportional and variable from 100% to 1%.
3) Adjustable for Integral and Derivative time factors.
4) Temperature deviation and percentage of power applied indicated on panel meters.
5) Cooling arrangement provided.
6) Fully self-contained unit with detailed instruction manual.
7) Heater lamps provided to increase the temperature of a model process (Aluminum block).

We can demonstrate how change in load brings about an offset error when in proportional mode and how the offset error can be almost eliminated when we introduce P+I mode.

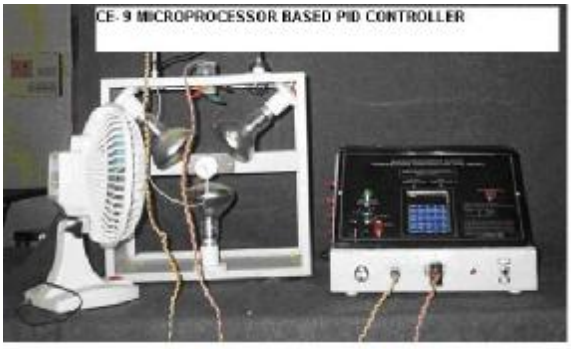


9) P.I.D. CONTROLLER (MICROPROCESSOR BASED) (CE-9)

The system is based on CPU, 8055,8155,8279, & 6116 RAM, the unit comes with 16 digit keyboard and 6 no. seven segment displays. The unit has following features.

1) PT 100 RTD with associated instrumentation card.
2) 12 bit ADC using IC 7109.
3) Study of A/D converter is also possible.
4) The software supplied facilitates experimentation in following modes.
   a)Proportional controller. b)Proportional + Integral controller. c)Proportional +Derivative d)P+I+D controller

The modes can be selected by proper selection of RAM contents. The Kp, Ki , Kd and set points are programmable. The system demonstrates working in the range 45 degree centigrade. A cooling fan is also provided to simulate load variations. Solid state relay controls the power to the model process.



10) WATER LEVEL CONTROLLER (ON/OFF MODE). (CE-10)

System is designed to give working demonstration will the help of
Mercury switch control.Electrode system.
Scope of supply includes:
Water tank: 75*30*30 cm with drain clock.
F. H. P. tullu motor with monoblock pump.Electronic unit.Instruction manual.

11) A. C. SERVO VOLTAGE STABILIZER AS SERVOMECHANISM. (CE-11)

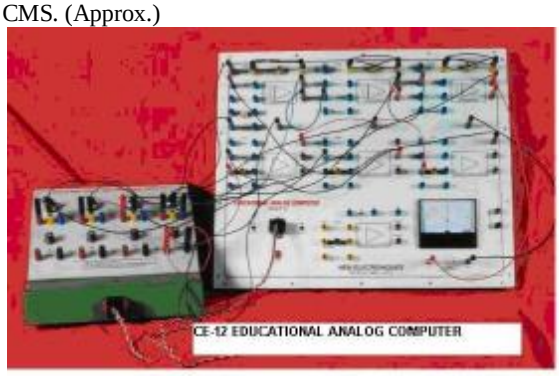
The unit facilitates supply of widely used servo controlled stabilizer as a closed loop control system.
The unit includes:

1) Control transformer.
2) Correcting dimmer.
3) Servomotor.
4) Load bank.
5) Electronic processing units with variable gain.
6) Voltmeter and ammeter included.
7) Test points provided on the side panel.
8) Acrylics cover for observing the working of the set up.
9) IKVA capacity for the stabilizer.

12) EDUCATIONAL ANALOG COMPUTER. (CE-12)

1) Set up includes 3 no. Integrators and 4 no. Summing amplifiers.
2) Power supply provided.
3) Precision ten turn pot to provide multiplication by a constant. Four numbers of such pots are provided.
4) Problems from control system laboratory can be readily simulated.
5) Output voltmeter provided.
6) Set of patch cords provided alongwith a detailed instruction manual.
7) Set up can be used to solve the vibration problems.
8) Mains operated unit.
9) Software is provided on a floppy to help analyze stability problems in control engg.

Dimensions of power units: 33*33*22 CMS.
Exp. Module: 61*50*10 CMS. (Approx.)



13) BOARD MODELS FOR ACTUATING ELEMENTS (CE-13)

Electropheumatic converter model
Input 0-20 ma (power supply provided to simulate input variations)Output variation 3 p.s.i. to 15 p.s.i.
Clean and regulated air supply of 20 p.s.i. required (to be supplied by the user)Detailed instruction manual.
FRL Unit provided with pressure gages for both input & output measurements.

14) CONTROL ENGINEERING TUTOR (PART I) (CE-14) (ROOT LOCUS OF PHASE SHIFT OSCILLATOR)
This set up facilitates complete study of simple phase of shift oscillator with following facilities on a neatly anodized experimental board.

a) Digital phase angle measurement in the range 0 to 180 degrees.
b) Frequency measurement in the range 30 Hz to 1000 Hz.
c) A. C. voltage measurement.

With the help of software provided alongwith the system, the student can find all the roots of characteristic equation and plot the complete root –locus of the system. The set up enables the student to measure the phase difference at various points if feedback network. The students can also measure the attenuation of the network and find the frequency at which system oscillates. The system comes with will illustrated instruction manual.

15) STUDY OF COMPENSATING NETWORK. (CE-15)
Compensating networks are used in control systems to improve the stability and performance of the system.
They are basically divided into 1) Lead 2) Lag 3) Lead Lag compensating network.
The set up is designed to facilitate the frequency response characteristic of these networks using op amps. The scope of supply includes,1.Basic circuitry ,2.Digital A. C. voltmeter up to 0 to 5 volts range.3.Digital phase angle meter.
The sinusoidal oscillator required for the measurement must be provided by user himself.
The unit consists of three parts.
1.Digital phase angle meter in the range 0 to 360 degrees
2.Digital A. C. voltmeter in the range of 0.1 volt to 5 volts.
3.Experimental module with lead, lag, limited lead, limited lag and lead-lag compensating networks using operational amplifiers. All pass network is also provided alongwith the system. The signal generator which can supply 6 volts RMS sinusoidal voltage in the frequency range 20 Hz to 1000 Hz is required to be supplied by the user. The experimental board also facilitates study of passive networks. The total system can also be used as study of active and passive filters set up.

16) A. C. POSITION CONTROL SYSTEM. (CE-16)
The system includes precision servo potentiometers, A. C. servomotor with gear train, servo amplifier and associated power supply alongwith test points and detailed instruction manual. The pair of precision servo potentiometers is working as error detector. This pair is excited with the help of floating 50 Hz supply. This output is amplified with the help of differential amplifier having very high CMRR. The differential amplifier output is further processed before it is fed to the control winding of A. C. servo motor (two phase) amplifier gain is controllable. Various test points facilitate clear understanding of the entire system. The set up comes with a neatly anodized front plate with transparent acrylic cover for clear view of the entire system.
Dimensions: 64*25*25 CMS.

17) D.C. SERVO MOTOR SPEED TORQUE CHARACTERISTICS. (CE-17) SCOPE OF SUPPLY:

1.D.C. servo motor
2.Speed measuring device.
3.Loading arrangement for servomotor.
4.Torque measuring system.
5.Detailed instruction manual.
6.Variable d. c. supply for d. c. servo motor. The d. c. servomotor is armature controlled and also field controlled. The armature voltage is variable from 0 to 30 volts and maximum load current capacity is 2 amps. The field voltage is also variable in the range 10 to 25 volts. The system comes with ammeter (0 to 2 amps load current) and speed indication (0 to 1500 RPM) with spring balance system for load measurement. The d. c. servomotor is coupled to the d. c. tacho generator, which facilitates the speed measurement. The armature voltage and field voltage can be measured with the help of DMM connected across the terminals on the panel.Dimensions: 64*25*25 CMS.

18) MAGNETIC AMPLIFIER. (CE-18)

Magnetic amplifier consists of combination of saturable reactors, rectifiers and load used to secure controlled amplification. In magentic amplifier, the load current in the circuit is controlled by a d. c. magnetising current, which is very low as compared to load current. To control the load current, a saturable reactor is used. The reactance of the reactor depends upon magnetic coupling and this magnetization depends upon D.C. control current. Thus the load current is controlled by magnetic amplifier is mainly used in following configurations.

1.Series connected magnetic amplifier.
2.Parallel connected magnetic amplifier.
3.Self saturated magnetic amplifier.

Magnetic amplifier unit is provided with elegant front panel and ammeters for indicating load current as well as control current. A controlling is provided on the front panel to adjust control current. All necessary connections are taken on the front panel by using patch cords. Different setups of magnetic amplifier configuration are can be demonstrated with this unit.

19) STUDY OF POTENTIOMETER AS ERROR DETECTOR. (CE-19)

Two numbers of precision potentiometers are used to demonstrate how an angular position can be converted into representative analog voltage and how the angle of misalignment between the two potentiometers can be accurately measured. A digital panel meter is used to provide this measurement. The set up comes with instruction manual.Dimensions: 54*18*20 CMS.

20) P. I. D. SIMULATOR. (CE-20)

This set up is designed to develop clear understanding of a typical PID controller with facility for proportional. Integral and Derivative control mode. The system can be patched up by the students with the help of instruction manual and labels and diagrams provided on the anodized top of the experimental board. Proportional gain, Integral time constant and Derivative time constant can be adjusted. The generation of offset of A/c of only proportional action can be understood. How this offset can be removed by means of integral mode (P+I) can be checked and the improvement in the dynamic response also can be demonstrated. This total set up is only a simulation of actual PID controller. The set up comes with one analog voltmeter and a digital voltmeter.

21) STEPPER MOTOR CONTROLLER. (CE-21)

A.Microprocessor based steeper motor controller: with a bifilar 2 phase D. C. stepping motor. The stepping motor can be programmed in three parameters namely,

Speed 2) No. of steps. 3) Direction.

It is specially designed low cost yet sophisticated control lab kit the microprocessor System consists of 8085 A CPU 8155 scratch pad and 8279 key board display controller and EPROM is used to enter application program for stepper motor is designed to demonstrate the basic principles of stepper motor with manual switching. The same contains power amplifiers and +12 volt regulated power supply.

The scope of the supply includes.

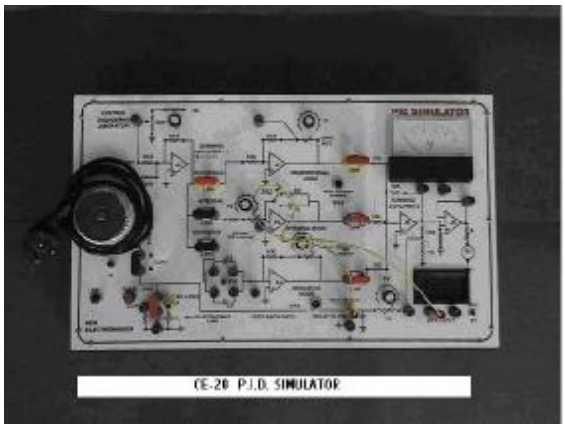
Stepper motor (3 kg-cm, 12 volts) with anodized dial for output shaft indication.

Power amplifier alongwiith regulated power supply driving the stepper motor.

Arrangement for manual operation of stepper motor control.

Microprocessor based controller for the stepper motor entire hardware including +5 volt regulated power supply. The set is associated with detailed and operating instruction manual.

B.Speed Torque Characteristic of Stepper motor 5 kg-cm, 400 RPM with direction control stepping frequency/RPM motor (Digital) using chopper drive with loading arrangement for stepper motor using spring balance.



CE-22. Linear System Simulator (Advanced Version):- (CE-22)

The Control Engineering Trainer is designed to study the First order ,Second order Control System. It also covers type0 And Type1 system. It consists of : 1)Gain Controllable Amplifier
2)One No. Of Integrator 3)Inductance Bank4)Variable Resistance
5)Capacitor Bank 6)Square wave generator with amplitude and frequency control.
7)impulse generator,sawtooth generator,and controllable DC output.
Amount of feedback can be controlled by a ten turn Helical Potentiometer.
Students can study of the effect of square and impulse Input on First and second order system. They can study Under damped , over damped and critically damped system.

List of experiments:-

1) Study of Amplifier , integrator and sign changer
2) Study of first order system (open loop with step input)
3) Study of second order system (LCR open loop with Step input)
4) Study of First order system (RC Close loop with step input)
5) Study of second order system (LCR close loop with Step input)
6) Study of second order system (With R1,C1 and R2,C2 closed loop)
7) Study of second order system (Type1 system:- R1 ,C1 and integrator system)
8) Study of Ramp input with type0 system.
9) Study of Ramp input for type1 system.
10) Study of closed loop RC with DC reference input and with integrator.

23.STUDY OF A.C.AND D.C.SERVOAMPLIFIERS(CE-23)

This unit is designed to study A.C. and D.C. servoamplifiers In combined unit. The unit is typically a board model withSeparate power supplies for both. In D.C. servo amplifier side Error voltage generator is provided (+ / - 0.5 V) which is then passed through voltage follower stage and op-amp preamplifier.This preamplifier is then given to driver stage.Driver's O/P is given to Power amplifier stage which is given to variable resistive load .Various test points are given to calculate the efficiency of the servo amplifier and to see the waveforms .

In A.C. servo amplifier A.C.error signal is passed through Instrumentation amplifier and then to driver stage and finallygiven to power amplifier stage. Various test points are given to calculate the efficiency of the servo amplifier and to see the waveforms .

24._Digital Control system simulation Kit. (CE-24)

This is basically PC based digital control kit. A Process simulation panel consisting Amplifier, voltage followers are provided.Also to simulate Time delays of the process variable Resistance and capacitors of suitable value are provided.Intermediate RS-232 interface unit is provided, which is having 8 channel ADC I/P (0- 5 V) and 1 DAC O/P (0 - 5V) .So This intermediate unit provides interface between PC and Process simulation panel. **A very powerful window based software is also provided .This software supports graphical presentation of process.**

Students can study open loop control system and closed loop control system.Control alogorithm used for closed loop control system is **P+I+D.** Necessary communication cable for RS-232 serial interface and patch cords are provided.

25.Microprocessor based D.C. Motor speed controller. (CE-25)

The system comes with microprocessor, I/O port , with ADC/DAC interface. The ½ HP d.c. motor coupled to d.c. tachogenerator as loading arrangement is driven by necessary power electronics using thyristors./IGBT .Isolation is provided between control circuit and power electronics ccts.Closed loop control system with PID algorithm can realized with the help of powerful user friendly software.appropriate test points are also provided on the setup. **Scope of supply :-**

1.Microprocessor based system with power electronics.
2.½ H.P. 1500 RPM ,200 V D.C.motor coupled to tachogenerator and loading arrangement.
3.Speed indication using DPM.
4.Control Range:- 300 RPM to 1200 RPM

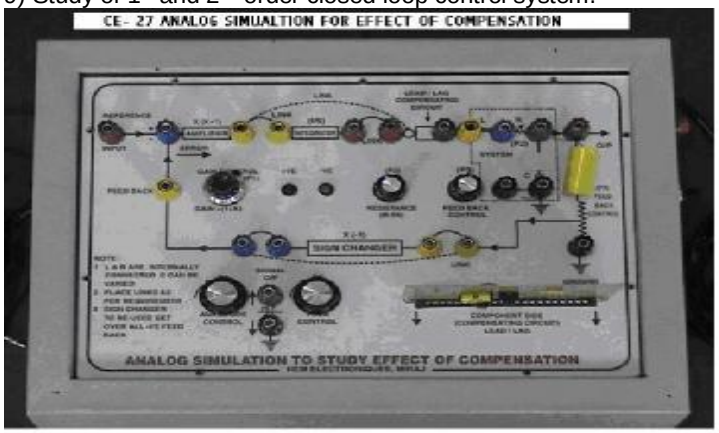
27. Analog Simulation to study the effect of Compensation. (CE-27)

(Linear System Simulator Basic Version)

Unit is typically Board model with complete self contained unit.It includes Amplifier,Integrator,Inductance , Variable resistance,Capacitance.It also houses inbuilt square wave generator with amplitude and frequency control.Also a sign changer block is provided to form negative feedback loop.Also a LEAD and LAG compensating circuitry is provided tostudy the effect of compensation.+12,-12v Inbuilt power supplies are provided.Following is the list the expts. which can be performed with the kit.

1)Study of amplifier
2)Study of integartor
3)Study of sign changer.
4)Study of 1st order system(open loop).
5)Study of 2nd order system(open loop)
6)Study of close loop system with simple RC network &integrator.
7)Study of close loop RC circuits(with integrator circuit)alongwith limited lead network.

8) Study of close loop RC circuits(with integrator circuit)alongwith limited Lag network.
9) Study of 1st and 2nd order closed loop control system.



LINEAR SYSTEM SIMULATOR (BASIC VERSION)

CE-28:D.C.Motor Speed controller using PID Controller–(CE-28)

D.C.Motor with 24 v, 2amp capacity is coupled to loading arrangement and D.C. tachogenerator . This motor can be used to control its speed in the range 200 RPM to 850 RPM with maximum current of 1.5 A using P,P+I,P+I+D mode by patching the system. Analog ammeter and digital RPM indicator are provided on an elegant polycarbonate panel l with neatly labeled diagram.

The system can be tested for open loop and closed loop operations. With closed loop operation the system can be tested for P,PI,PID modes and student can study the effect of proportional gain, integral gain and derivative gain. Also they can observe study state error performance of the setup. System can be disturbed by load change or by change in field excitation. The system comes with D.C motor mounted on the base plate with loading arrangement, and neatly labeled and printed polycarbonate front panel and detailed experimental manual.

Scope Of Supply:
1) D.C. motor
2) Loading Arrangement.
3) Control Circuit.
4) Power Circuit.
5) Digital Indicator.
6) Ammeter.
7) Spring Balance.