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# North Maharashtra University, Jalgaon

## Syllabus for Third Year Engineering Degree Course in

# INSTRUMENTATION ENGINEERING

(w.e.f. July, 2000)

North Maharashtra University, Jalgaon

Syllabus for T.E. (Instrumentation Engineering)

(With effect from July, 2000)

**Term I**

| Sr. No. | Subject Code | Subject | Teaching Scheme Hours / Week | | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Lectures | Practical | Paper duration Hours | Maximum Marks | | | |
| | | | | | | Paper | Termwork | Practical | Oral |
| 1 | | Microprocessor Techniques | 4 | 2 | 3 | 100 | 25 | 25 | – |
| 2 | | Linear Techniques | 4 | 4 | 3 | 100 | 25 | 25 | – |
| 3 | | Automatic Control Systems | 4 | – | 3 | 100 | 25 | – | – |
| 4 | | Control System Components | 4 | 2 | 3 | 100 | 25 | 25 | – |
| 5 | | Electronic Instrumentation | 4 | 2 | 3 | 100 | 25 | – | – |
| | | Total | 20 | 10 | – | 500 | 125 | 75 | – |
| | | | 30 | | – | 700 | | | |

**Term II**

| Sr. No. | Subject Code | Subject | Teaching Scheme | | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Lectures | Practical | Paper duration Hours | Maximum Marks | | | |
| | | | | | | Paper | Termwork | Practical | Oral |
| 1 | | Computer Techniques | 4 | 2 | 3 | 100 | 25 | 25 | – |
| 2 | | Analytical Instrumentation | 4 | 2 | 3 | 100 | 25 | – | – |
| 3 | | Modern Control Theory | 4 | 4 | 3 | 100 | 25 | 25 | – |
| 4 | | Industrial and Power Electronics | 4 | 2 | 3 | 100 | 25 | 25 | – |
| 5 | | Engineering Economics and Resource Management | 4 | – | 3 | 100 | – | – | – |
| 6 | | Practical Training / Special Study/ Minor Project | – | – | – | – | 25 | – | – |
| | | Total | 20 | 10 | – | 500 | 125 | 75 | – |
| | | Grand Total | 30 | | – | 700 | | | |

Total Marks of Term I + Term II = 1400

## Term I Paper 1
## Microprocessor Techniques

Teachnig Scheme :
Lectures : 4 Hrs./week
Practical : 2 Hrs./week

Examination Scheme :
Paper : 100 marks
(3 Hrs. duration)
Termwork : 25 marks
Practical : 25 marks

**Unit 1**

Introduction to microprocessors : microcomputer systems; computer languages; microprocessor architecture, operation with memory and input/output devices; 8085 based microprocessor systems. Instructions : Format, classifications, timing diagrams, machine cycles, status flags, basic instructions; assembly language programs. (10 Hrs.) (20 marks)

**Unit 2**

Additional instructions and programming techniques : looping, counting, indexing; data transfer and 16 bit arithmatic instructions; logic operations.

Stack, subroutines, conditional call and return. Basic concepts in serial I/Os, software controlled asynchronous serial I/Os.

(10 Hrs.) (20 marks)

**Unit 3**

Code conversion : BCD to binary, binary to BCD.

BCD arithmatics and data operations : BCD addition and substraction.

Introduction to advanced instructions and applications : multiplication and division.

Basic interfacing concepts : interfacing displays, keyboards, and memory.

I/O mapped I/O and memory mapped I/O. Interrupts and interrupt structure of 8085, reset as software interrupt.

(10 Hrs.) (20 marks)

**Unit 4**

Programmable I/Os and interfacing applications : basics of programmable I/O devices, programmable peripheral interface 8255, programmable interval timer 8253, counter and time delay applications.

Programmable interrupt controller 8259, DMA controller 8257.

(10 Hrs.) (20 marks)

Keyboard display interface 8279.

Floppy disk controller 8272.

CRT controller 8275.

Connection diagram and interfacing for each IC.

**References :**


1. Microprocessor Architecture, Programming and Applications with the 8085, third edition, Ramesh S. Gaonkar, Penram International (India).
2. Introduction to microprocessors, third edition, A.P. Mathur, Tata McGraw-Hill.


**List of Experiments :**

1. Programs for addition and substraction.
2. Programs for multiplication and division
3. Programs for up/down BCD/binary counters.
4. Program for serial data transfer.
5. Program for rotating display.
6. Program for block transfer.
7. Program for input/output operations.
8. Program using 8253.
9. DMA controller.
10. Interrupt controller.
11. Floppy disk controller.
12. CRT controller.

The termwork should include a minimum of eight experimets from the above list. The termwork marks will be based on performance in theory and practicals having a weightage of 40% and 60% respectively.

## Term I Paper 2
## Linear Techniques

Teaching Scheme :
Lectures : 4 Hrs./week
Practicals : 4 Hrs./week

Examination Scheme :
Paper : 100 marks
(3 Hrs. duration)
Termwork : 25 marks
Practical : 25 marks

**Unit 1**

Differential amplifiers : dual input-balanced and unbalanced outputs; single input - balanced and unbalanced outputs; their analysis, constant current bias, current mirrors, level translators. Basic operational amplifier, equivalent circuit, IC operational amplifiers–characteristics, specifications, parameter measurements, frequency response, types (741, 308, 356, OP07) and their properties.

(10 Hrs.) (20 marks)

**Unit 2**

Negative feedback applications : Voltage amplifiers, current amplifier, voltage to current and current to voltage converters; op-amps as integrators and differentiators; instrumentation amplifiers.

Positive feedback applications : crystal oscillators, and function generators. (10 Hrs.) (20 marks)

**Unit 3**

Comparators and Converters : basic comparator, zero-crossing detector, Schmitt trigger, precision AC/DC converters, logrithmic amplifiers, using op-amps; sample-and-hold circuits; analog-to-digital, and digital-to-analog convertors; clippers and clampers.

(10 Hrs.) (20 marks)

**Unit 4**

Timer ICs. – Timer 555, its block diagram and applications – astable, monostable multivibrators; Timers – 7555 and XR 2240, their block diagrams and applications.

Phase locked loops (PLLs) – operating principles, IC 565 applications. Voltage controlled oscillator (VCO) and its applications.

(10 Hrs.) (20 marks)

**Unit 5**

Voltage regulators – 3 terminal positive and negative voltage regulators, variable voltage regulators (3085, 723), tracking regulators.

Active filters : Butterworth, Chebychev filters, design and evaluation of second order filters – low pass, high pass, band pass, band reject, and all pass filters; [illegible]

(10 Hrs.) (20 marks)

**References :**


1. Op-Amps and Linear Integrated Circuits, Second edition, Ramakant A. Gayakwad, Prentice-Hall of India.
2. Operational Amplifiers : Design and Applications, Graeme, Tobey and Huelsman, McGraw-Hill International edition.
3. Linear Integrated Circuits, D.Roy Choudhury and Shail Jain, New Age International.
4. Electronic Principles, 6th edition, Albert Paul Malvino, Tata McGraw-Hill.


**List of Experiments :**

**Group A**

1. Op-Amp parameters.
2. Instrumentation amplifier.
3. Function generator using op-amps.
4. Crystal oscilletor
5. Half-wave precision rectifier.
6. Full-wave precision rectifier.
7. Zero-crossing detector.
8. Schmitt trigger.

**Group B**

9. Clipper/Clamper circuits.

3....

10 A/D and D/A converters.
11. IC voltage regulators.
12. Butterworth second order low-pass/high-pass filter.
13. Butterworth second order band-pass/band-reject filter.
14. Astable multivibrator using IC 555.
15. Monostable multivibrator using IC 555.
16. Application of phase locked loop PLL 565.

The termwork should include a minimum of twelve experiments six each from groups A and B. The termwork marks will be based on performance in theory and practicals having a weightage of 40% and 60% respectively.

## Term I Paper 3
## Automatic Control Systems

Teachnig Scheme :
Lectures : 4 Hrs./week

Examination Scheme :
Theory : 100 marks
Termwork : 25 marks

**Unit 1**

Introduction to linear control systems : open-loop and close-loop (feedback) control systems; effects of feedback on gain, stability, sensitivity, noise; types of feedback control systems—linear vs nonlinear, time-invariant vs time-varying, continuous-data, sampled-data and digital control systems. Writing differential equations for any given (electrical, mechanical) control system and to determine transfer function.

Transfer function by block diagram reduction techniques and by signal-flow-graph analysis using Mason's gain formula.

(10 Hrs.) (20 marks)

**Unit 2**

Time-domain analysis of control systems for different test signals, step, ramp and parabolic. Steady-state response of various types (0,1,2,3) of systems, steady-state performance specifications. Transient response of a second order system, performance specifications, dominant poles of transfer functions, stability of control systems, absolute and relative. (10 Hrs.) (20 marks)

**Unit 3**

Methods of determining stability of linear control systems, Routh-Hurwitz criterion; root locus technique, effect of adding a pole/zero on stability, root sensitivity-robustness of system. (10 Hrs.) (20 marks)

**Unit 4**

Frequency-domain analysis of control systems : Nyquist stability criterion; frequency-domain characteristics; Mp, ωp, and the bandwidth of a second order system; relative stability—gain margin, phase margin and Mp. (10 Hrs.) (20 marks)

**Unit 5**

Graphic methods of determining gain margin and phase margin : Bode plots; constant M and N loci in the magnitude-versus-phase plane—Nichols chart; phase-lead, and phase-lag compensation by Bode plots. (10 Hrs.) (20 marks)

**References :**


1. Automatic Control Systems, fifth edition, Benjamin C. Kuo, Prentice-Hall of India.
2. Control Systems : Principles and Design, M.Gopal, Tata McGraw-Hill.
3. Linear Control System : Analysis and Design, fourth edition, John D'Azzo and Constantine Houpis, McGraw-Hill International edition.

## Term I Paper 4
## Control System Components

Teaching Scheme:
Lectures : 4 Hrs./week
Practical : 2 Hrs /week

Examination Scheme:
Paper : 100 marks
(3 Hrs. duration)
Termwork : 25 marks
Practical : 25 marks

**Unit 1**

Introduction to control system components : electrical, mechanical, hydraulic, pneumatic; comparison of different systems: representation of control components.
Transmitters : buoyancy, differential pressure, temperature, electro-hydraulic, 2-wire transmitters.
Converters : resistance-to-current, voltage-to-current, pneumatic-to-electrical, electrical-to-pneumatic. (10 Hrs.) (20 marks)

**Unit 2**

Control actions : On/off-two position, three position, time proportionating; proportional (P), integral (I), derivative (D), PI, PD, PID; differential gap, rate before reset, offset in P action, effect of process characteristics on PID combination action.
PID controllers : pneumatic, hydraulic, and electronic controllers; auto-manual transfers, frequency response, installation and tuning. (10 Hrs.) (20 marks)

**Unit 3**

Sequential and timing control applications : relay ladder diagrams; introduction to programmable logic controller (PLC), architecture and specifications, development of simple ladder diagram, PLC applications.
Control Valves : terminology, types and characteristics, selection criteria; concept of Cv, calculation of Cv and trim size. (10 Hrs.) (20 marks)

**Unit 4**

Valve positioners : necessity, types and effect on performance of control valve; actuators - pneumatic, hydraulic, electrical, electro-pneumatic, electro-hydraulic.
Hydraulic components : pumps, power cylinders, servomotors, valves, power supply, simple hydraulic circuits and transmission. (10 Hrs.) (20 marks)

**Unit 5**

Auxiliary process components : Variable speed drives, fluidic dampers, square root extractor, computing relays, fluidic gates, high/low selectors, differential links and gears, amplidyne, magnetic amplifiers, synchros, reed switches, Intrinsic safety components, integrator, totalizer, air filter regulator. (10 Hrs.) (20 marks)

**References :**


1. Process control and Instrument Technology, fourth edition, C.D. Johnson, Prentice-Hall of India.
2. Principles of process control, second edition, D. Patranabis, Tata McGraw-Hill.
3. Instrument Technology Vol.III, E.B. Jones.
4. Instrumentation for process Measurement and Control, N.A. Anderson.
5. Process Control, P. Harriott.
6. Industrial Hydraulics, Pipepinger.
7. Automatic Control Engineering, fifth edition, Francis Raven, McGraw-Hill International edition.


**List of Experiments :**

**Group A**

1. Calibration and tuning of a PID controller.
2. Test and find transfer function of a given control valve
3. Study of Hydraulic components and simple hydraulic circuits.
4. Study of pneumatic components and simple pneumatic circuits.
5. Study of Two-wire transmitter and square-root extractor.
6. Study of flow control loop.

**Group B**

7. Study of alarm annunciator.
8. Study of I to P, P to I and I to pulse converter.

9. Study of PLC and simple programming on PLC.
10. Study and calibration of a DP transmitter for flow/level interface.
11. Study of magnetic amplifier, synchros.
12. Study of specific/related equipment e.g. RTD, TC, PH simulator, pressure regulator, safety devices.

The termwork should include a minimum of eight experiments four each from groups A and B. The termwork marks will be based on performance in theory and practicals having a weightage of 40% and 60% respectively.

## Term I Paper 5
## Electronic Instrumentation

Teaching Scheme :
Lectures : 4 Hrs./week
Practical : 2 Hrs./week

Examination Scheme
Paper : 100 marks
(3 Hrs. duration)
Termwork : 25 marks

**Unit 1**

Characteristics of electronic hardware, active and passive components testing and measurement - ohm meters, milli/micro ohm meters, capacitance meter, RLC meter, tan δ, insulation testers.
Oscilloscopes : architecture, CRT structure and design, sweep modes, passive and active probes, special purpose oscilloscopes like--storage, sampling, digital readout, multitrace. (10 Hrs.) (20 marks)

**Unit 2**

Signal sources : sinusoidal signal sources, pulse generators, frequency synthesis, square wave generators, function generators. Analog switches and multiplexers, sample and hold circuits, programmable amplifiers, lock-in amplifiers. (10 Hrs.) (20 marks)

**Unit 3**

Voltage-to-time, voltage-to-frequency and frequency-to-voltage converters, digital frequency counters and timers. Digital voltmeters, Digital multimeters, true RMS meter, vector voltmeter. (10 Hrs.) (20 marks)

**Unit 4**

Quantization and sampling, A/D and D/A techniques, data logger, supervisory control and data acquisition systems. Modulation techniques, analog and digital data transmissin systems, telemetry. (10 Hrs.) (20 marks)

**Unit 5**

Signal analysis : distortion analyser, wave analyser, spectrum analyser, introduction to DFT and FFT, FFT analyser. Interference and noise, shielding and grounding techniques, isolation problems, opto-isolators. (10 Hrs.) (20 marks)

**References :**


1. Electronic Instrumentation and Measurement Techniques, third edition, Cooper and Helffric, Prentice-Hall of India.
2. Electronic Instrumentation and measurement, chin and Jones, wiley.
3. Elements of Electronic Instrumentation and Measurement, second edition, J.J. Carr, Reston.
4. Electronic Instrumentation and Measurement, Oliver and Cage, McGraw-Hill.
5. Instrumentation Devices and Systems, Rangan, Sarma, Mani, Tata McGraw-Hill.
6. Application of Analog Integrated circuits, S. Soclof, Prentice Hall.


The termwork should include a minimum of eight experiments based on the above topics. The termwork marks will be based on performance in theory and practicals having a weightage of 40% and 60% respectively.

## Term II Paper I
## Computer Techniques

Teaching Scheme :
Lectures : 4 Hrs./week
Practical : 2 Hrs./week

Examination Scheme :
Paper : 100 marks
(3 Hrs. duration)
Termwork : 25 marks
Practical : 25 marks

**Unit 1**

Computer Systems : Introduction, basic subsystems and organization; introduction to computer applications in numerical computations; information and data processing. Fundamentals of disc operating system (DOS) : Installation of DOS and its basic structure, features of COM and EXE files, device handling by DOS, hardware basic-input-output-system (BIOS), DOS interrupts.

(10 Hrs.)(20 marks)

**Unit 2**

Disks and files under DOS, logical structure of a disk and its organization, file organization on a DOS disk, manipulating files under DOS.

DOS functions of INT21H, interrupt handling through DOS, memory allocation and management, program loading and execution.

(10 Hrs.)(20 marks)

**Unit 3**

Personal computers : concepts and techniques, hardware organization, motherboard logic, I/O port addresses and data transfer, ROM-BIOS services.

Microprocessors in PC : 8086/8088/8087 architecture, organization, bus structure and timings, floating point arithmatic.

(10 Hrs.)(20 marks)

**Unit 4**

8086/8088/8087 instruction set, assembly language programming and execution.

Floppy disk controller (FDC) system interface : Floppy disc subsystem operation, FDC IC and commands, disc format, CRT display, display adapters (CGA, EGA and VGA) and interfacing.

(10 Hrs.)(20 marks)

**Unit 5**

Hard disc controller (HDC) system : organization, disc drive types and interfacing, HDC commands and ports, hard disc card, format and format procedure.

Printer controller, serial/parallel communication interfaces, RS-232, IEEE-422, IEEE-488, centronics interface, hardware overview, universal synchronous asynchronous reciever transmitter-8251, interfacing analog to digital and digital to analog data converters.

(10 Hrs.)(20 marks)

**References :**


1. Microprocessors and Interfacing, second edition, Douglas V. Hall, Tata McGraw-Hill.
2. IBM PC and clones, B. Govindarajalu, Tata McGraw-Hill.
3. Advanced Microprocessors and IBM-PC Assembly Language Programming, Udaya Kumar, Tata McGraw-Hill.
4. Hardware and Software of PC, Sanjay Bose, New Age International.


**List of Experiments :**

Group I : Bringing up/backing up DOS, resident/non-resident DOS commands, boot record, file allocation table, directory and sub-directory (md,rd,cd), file attributes, volume labels, format, line editor, debug.

Group II : Programming exercises on 8086/8088/8087.

Group III : Interfacing A/D and D/A data converters.

The termwork should include a minimum of eight experiments two from group I, four from group II and two from group III. The termwork marks will be based on performance in theory and practicals having a weightage of 40% and 60% respectively.

## Term II Paper 2
## Analytical Instrumentation

Teaching Scheme :
Lectures 4 hrs./week
Practicals . 2 hrs./week

Examination Scheme :
Paper : 100 marks
(3 Hrs. duration)
Termwork : 25 marks

**Unit 1**

Introduction to chemical instrumental analysis : advantages over classical methods, classification–spectral, electroanalytical and separative methods, introduction to each method.

U.V. and VIS absorption methods : laws of photometry, Beer and Lambert's law, U.V. and VIS absorption instrument components, monochromator design and associated equipment, monochromator performance.

U.V. and VIS instruments : Colorimeters, single beam and double beam spectrophotometers, duel wavelength and double monochromator systems, diode array rapid scanning spectrophotometers; reverse optics technique; infra-red (IR) spectrophotometers; Fourier transform teachnique

(10 Hrs.)(20 marks)

**Unit 2**

Emission spectrophotometry : theoritical concepts; instrumentation–source unit, electrodes, mountings like–Rowland circle, Wadeworth, Seyanamioka, Eagle; direct reading multichannel spectrophotometers.

Flame photometry : Principle, constructional details, fuel gases, atomizer, burner, optical system, recording system.

Atomic absorption spectrophotometers : theoritical concepts, instrumentation–hollow cathode lamps, burners and flames, plasma excitation sources, optical and electronic systems.

(10 Hrs.)(20 marks)

**Unit 3**

Nuclear Magnetic Resonance (NMR) spectrometry : Principle, nuclear spin, nuclear energy levels, resonance condition, NMR absorption spectra, chemical shift, constructional details of NMR spectrometer, sensitivity enhancement techniques, spin decoupler : Fourier transform NMR spectroscopy; Electron spin resonance (ESR) spectrometry–principle, constructional details.

Fluorimeters and phosphorimeters : Principle, single and double beam filter fluorimeter, ratio fluorimeter, spectrofluorimeter, microprocessor-based instruments, phosphorescence spectrometer. Raman Spectrometry : Raman effect, Raman spectrometer components, LASER Raman spectrophotometer, photoacoustic and photothermal spectrometers. (10 Hrs.)(20 marks)

**Unit 4**

Mass spectrometry : basic mass spectrometer components, types–magnetic deflection type, time of flight, ratio frequency, double focussing, quadrupole type; Gas chromatograph mass spectro-meter–GCMS systems ; resolution of mass spectrometer, applications.

Electron and ion spectroscopy : surface spectroscopic techniques, electron spectroscopy for chemical analysis (ESCA), Auger spectroscopy (AES), secondary ion mass spectrometry (SIMS) and ion scattering spectroscopy (ISS).

Radio chemical instrumentation : radio chemical methods, radiation detectors – ionization chamber, Geiger Muller counter, proportional counter, scintillation counter, semiconductor detectors, pulse height analyser. X-ray spectrometry : X-ray spectrum, instrumentation for X-ray spectrometry, X-ray diffractometers, X-ray absorption meter. (10 Hrs.)(20 marks)

**Unit 5**

Gas and liquid chromatography : classification : basic parts of gas chromatograph – carrier gas, sample injection system, chromatographic column, thermal compartment, temperature programming, dual column system, detectors-thermal conductivity, flame ionization, electron capture, Argon ionization detector, recording instruments; introduction to liquid chromatography

Other methods of gas analysis – oxygen, carbon monoxide, carbon dioxide, Nitrogen analyzer, gas density analyzers.

Refractometry : Principle, Abbe and dipping type refractrometer.

Interferometry : Principle, types-Rayleigh, Jamin and Twyman interferometers.

Moir technique : ntroduction and use as a traneducer for length measurement.

(10 Hrs.)(20 marks)

**References :**


1. Handbook of Analytical Instruments, R.S. Khandpur, Tata McGraw-Hill.
2. Principles of Industrial Instrumentation, second edition, D.Patranabis, Tata McGraw-Hill.
3. Instrumental methods of Analysis, Willard, Merrit, Dean
4. Instrumental Methods of Chemical Analysis, E.W. Ewing.
5. Introduction to Instrumental Analysis, Robert D. Braun.

**List of Experiments :**

1. Study of filter photometer.
2. Study of flame photometer.
3. Study of Densitometer.
4. Study of spectrophotometer (Visible and infra-red region).
5. Study of single beam spectrophotometer for UV/VIS range.
6. Study of double beam spectrophotometer for UV/VIS range.
7. Study of mass spectrometers.
8. Study of gas chromatographs.
9. Study of liquid chromatographs.
10. Study of refractometer.
11. Study of interferometer.
12. Study of N.M.R. and E.S.R. spectrometer.
13. Study of atomic absorption spectrophotometer.
14. Paper design of any analytical instrument.

The termwork should include a minimum of eight experiments from the above list. The termwork marks will be based on performance in theory and practicals having a weightage of 40% and 60% respectively.

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## Term II Paper 3
## Modern Control Theory

Teaching Scheme :
Lectures : 4 Hrs./week
Practicals : 4 Hrs./week

Examination Scheme :
Paper : 100 marks
(3 Hrs. duration)
Termwork : 25 marks
Practical : 25 marks

**Unit 1**

State-space representation : definitions of state, state variables, state vector, state space; representation of multi input-single output system and multi input-multioutput system; properties of state transition matrix, determination of state transition matrix, solution of homogenous and non-homogenous state equations, time domain response from state transition matrix; non-interaction of multiinput - multi output systems, linear time varying systems. (10 Hrs.)(20 marks)

**Unit 2**

Sampling and reconstruction : sampled data control system, D to A and A to D conversion, sample and hold operation and its mathematical model, sampling theorem.

Linear difference equations; pulse-response; z-transforms. Relation between z-plane and s-plane; pulse transfer function. (10 Hrs.)(20 marks)

Unit 3

Analysis of sampled - data systems ; block diagram analysis equivalence between z-domain and s-domain, stability analysis—systems with dead time.

Unit 4→ State space analysis of sampled data systems : discrete time state equations, similarity transformations, Cayley-Hamilton theorem, realisation of pulse transfer function, state equations of sampled data system and its example.

Controllability and observability : concept, Lyapunov stability analysis, systems with dead time. (10 Hrs.)(20 marks)

Unit 5→ Digital control systems : introduction, design specifications, design of w-plane, digital PID controller, multivariable controllers.

Design of digital control system using state-space formulation of optimal control problem, optimal state regulator. (10 Hrs.)(20 marks)

**References :**


1. Modern Control Engineering, second edition, Katsuhiko Ogata, Prentice-Hall of India.
2. Control Engineering, G.J. Murphy.
3. Digital Control Systems, Kuo.
4. Modern Control System Theory, second edition, M.Gopal, New Age International.
5. Digital Control Engineering, M. Gopal, New Age International.

8 Digital Control Systems, Houps and Lamont, McGraw-Hill international edition.

The termwork should include a minimum of eight experiments on the topics from Automatic Control Systems (T.E., Term I, Paper 3) and the above topics. The termwork marks will be based on performance in theory and practicals having a weightage of 40% and 60% respectively.

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## Term II Paper 4
## Industrial and Power Electronics

Teaching Scheme
Lectures . 4 Hrs./week
Practical : 2 Hrs./week

Examination Scheme .
Paper : 100 marks
(3 Hrs. duration)
Termwork : 25 marks
Practical : 25 marks

**Unit 1**

Thyristors : SCR, Triac, Diac, SCS, SUS, LASCR, device characteristics and symbolic representation, constructional details; Methods of turning on an SCR, turn-on characteristics, turn-off mechanism, turn-off characteristics; device specifications, ratings and nomenclature; SCR triggering circuits, R, RC, pulse and UJT triggering circuits; internal power dissipation and temperature rise. Multiple connections of SCRs : series operation, triggering; parallel operation, triggering; string efficiency. Applications . static circuit breaker ac, and dc; overvoltage protection circuit; zero voltage switch; integral-cycle triggering; time delay circuit; soft start circuit. (10 Hrs.)(20 marks)

**Unit 2**

Line-commutated controlled rectifiers . single-phase and three-phase controlled-rectifier circuits, B-2 and B-6 connections; Voltage and current wave forms.

Inverters : Forced commutation circuits, class A,B,C,D,E and F; parallel inverter, principle of operation and output voltage waveform; series inverter, principle of operation, voltage and current waveforms; bridge inverter, commutation circuits, principle of operation; uninterruptible power supply, block diagram, principal of working. (10 Hrs.)(20 marks)

**Unit 3**

Choppers : Chopper control of dc motor, chopper circuits, oscillating chopper, Jones chopper, Morgan chopper, step-up chopper, two-quadrant chopper, AC chopper, circuit and principle of operation for each method.

Power supplies : constant current power supply, switching mode power supply. (10 Hrs.)(20 marks)

Unit 4→ AC voltage regulators. Introduction to cycloconverters. Induction and dielectric heating. Resistance welding. (10 Hrs.) (20 marks)

Unit 5→ Speed control of single-phase induction motor : using triac, using inverter, circuit diagrams and principle of working.

Thyristor control circuits : temperature regulator, SCR-controlled dimmer circuit, emergency light using SCR, automatic water level indicator, automatic battery charger using SCR, circuit diagram and principle of operation for each application. ultrasonics and applications. (10 Hrs.)(20 marks)

**References :**


1. An Introduction to Thyristors and their Applications, second edition, M. Ramamoorty, East-West Press
2. Industrial Electronics and Control, S.K. Bhattacharya, S. Chatterjee, Tata McGraw-Hill.
3. Power Electronics, P.C. Sen, Tata McGraw-Hill.
4. Power Supplies, B.S. Sonde.


The termwork should include a minimum of eight experiments from the above topics. The termwork marks will be based on performance in theory and practicals having a weightage of 40% and 60% respectively.

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## Term II Paper 5

## Engineering Economics and Resource Maagement

Teaching Scheme :
Lectures : 4 Hrs./week

Examination scheme :
Paper : 100 marks
(3 Hrs. duration)

**Unit 1**

Meaning of the term Engineering Economy. Definitions, nature and scope of Economics. Laws of consumption. Utility and demand, elasticity of demand, demand and supply – their relationship, indifference curves. (10 Hrs.)(20 marks)

**Unit 2**

Production – its meaning, different factors of production, efficiency of labour, division of labour, specialization, scales of production, marginal productivity theory. Different forms of organization, their working, trade unions and labour relations. (10 Hrs.)(20 marks)

**Unit 3**

Money cost, real cost, opportunity cost – their relationship. Average, marginal, fixed and variable costs – their relationship to cost of production. Pricing under perfect and monopolistic conditions. (10 Hrs.)(20 marks)

**Unit 4**

Money – its evolution, value of money. Banks – its meaning, different types of banks, functions of commercial and central banks.

Banking in a developing economy. Methods of raising finance and institutions of industrial finance. (10 Hrs.)(20 marks)

**Unit 5**

Financial Planning, capitalization and capital structure, working capital, dividends, public deposists and loans. Capital market and its constituents. Appraisal of capital market institutions. Speculation, its uses and abuses, role of speculation in organised markets. (10 Hrs.)(20 marks)

**References :**


1. Modern Economic Theory,
2. Business Organization and Management, S.A. Sherlekar.
3. Production Planning, Control and Industrial Management, Jain and Agrawal.
4. Elementary Economic Theory, R.D. Gupta.


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## Term II Subject 6 Temwork

## Practical Training / Special study / Minor Project

Examination Scheme :
Temwork : 25 marks

Every student need to complete the following requirements for termwork of practical training / Special study / Minor project.

Practical training in any industry for a period of minimum two weeks and submit training report certified by personnel manager or works manager or any other higher authority of that industry.

OR

Special study on a recent topic from reported literature and submit a report on it.

OR

One mini theoritical or fabrication project and submit a report on it.

OR

Attend a course of Enterpreneurship Development course conducted by college and submit a report on it.

Note :

1. Practical training is to be undergone in summer vacation after S.E. and/or in winter vacation after the first term of T.E.
2. Report should be typed on A4 size paper and three copies paper bounded are to be prepared, one copy is for the candidate, one for the library and one for the teacher concerned.