University of Pune, Pune

SE Instrumentation and Control (2013 Course)

SEMESTER- I

Subject code	Subject	Teaching Scheme			Examination Scheme					Total
		TH	PR	Tut	TH		PR	Oral	TW	
					Online	Paper				
	Engineering Mathematics III	4	--	1	50	50	--	--	25	125
206261	Sensors and Transducers	4	2	--	50	50	50	--	25	175
206262	Linear Integrated Circuits	4	2	--	50	50	50	--	--	150
206263	Basic Instrumentation	4	2	--	50	50	--	50	--	150
206264	Photonics and Instrumentation	4	--	--	50	50	--	--	--	100
206265	Data Structures and files	--	2	1	--	--	--	--	50	50
		20	**8**	**02**	**250**	**250**	**100**	**50**	**100**	**750**

SEMESTER- II

Subject code	Subject	Teaching Scheme			Examination Scheme					Total
		TH	PR	Tut	TH		PR	Oral	TW	
					Online	Paper				
206266	Transducers & Signal Conditioning	4	2	--	50	50	50	--	--	150
206267	Electronics Instrumentation	4	2	--	50	50	--	--	50	150
206268	Automatic Control System	4	2	--	50	50	--	50	--	150
206269	Digital Techniques	4	2	--	50	50	50	--	--	150
206270	Industrial Drives	3	--	--	50	50	--	--	--	100
206271	Communication Skill	1	2	--	--	--	--	--	50	50
		20	**10**	**--**	**250**	**250**	**100**	**50**	**100**	**750**

UNIVERSITY OF PUNE

For Electrical + SW / Instrumentation Engineering (Sem I)

207006 ENGINEERING MATHEMATICS – III (2012 Course)

Teaching Scheme:
Lectures – 4 Hrs./Week
Tutorials – 1 Hr./Week

Examination Scheme:
Paper – 50 Marks (2 Hrs.)
Online – 50 Marks
Term work: 25 Marks

Section I

Unit I: Linear Differential Equations (**LDE**) and Applications (09 Hours)

LDE of n^{th} order with constant coefficients, Method of variation of parameters, Cauchy's & Legendre's DE, Simultaneous & Symmetric simultaneous DE. Modeling of Electrical circuits.

Unit II: Laplace Transforms (09 Hours)

Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. Periodic, Unit Step, Unit Impulse. Applications of LT for solving Linear differential equations.

Unit III: Fourier and Z - Transforms (09 Hours)

Fourier Transform (**FT**): Complex exponential form of Fourier series, Fourier integral theorem, Sine & Cosine integrals, Fourier Transform, Fourier Sine and Cosine Transform and their Inverses.

Z - Transform (**ZT**): Introduction, Definition, Standard properties, ZT of standard sequences and their inverses. Solution of difference equations.

Section II

Unit IV: Vector Differential Calculus (09 Hours)

Physical interpretation of Vector differentiation, Vector differential operator, Gradient, Divergence and Curl, Directional derivative, Solenoidal, Irrotational and Conservative fields, Scalar potential, Vector identities.

Unit V: Vector Integral Calculus and Applications (09 Hours)

Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem. Applications to problems in Electro-magnetic fields.

Unit VI: Complex Variables (09 Hours)

Functions of Complex variables, Analytic functions, Cauchy-Riemann equations, Conformal mapping, Bilinear transformation, Cauchy's integral theorem, Cauchy's Integral formula, Laurent's series, Residue theorem.

Text Books:

1. Advanced Engineering Mathematics, 9e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).

Reference Books:

1. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
2. Advanced Engineering Mathematics, Wylie C.R. & Barrett L.C. (McGraw-Hill, Inc.)
3. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
4. Applied Mathematics (Volumes I and II) by P. N. Wartikar & J. N. Wartikar (Pune Vidyarthi Griha Prakashan, Pune).
5. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
6. Advanced Engineering Mathematics with MATLAB, 2e, by Thomas L. Harman, James Dabney and Norman Richert (Brooks/Cole, Thomson Learning).

Tutorial and Term Work:

i) Tutorial for the subject shall be engaged in minimum of four batches (batch size of 20 students Maximum) per division.

ii) Term work shall consist of six assignments (one per each unit) based on performance and continuous internal assessment.

A S Mujumdar

[206261] Sensors and Transducers

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

Examination Scheme:
Paper: 100 Marks
Practicals: 50 Marks
TW: 25 Marks

Unit I:

Motional and Dimensional measurement:

Introduction, Aim of measurement, Roll of sensors in engineering, classification of transducers, Fundamental Standards, units

Linear Displacement: Resistive Potentiometers, stain gauge, LVDT, Capacitive Piezoelectric, Hall Effect sensors, magnetostricitive, magnetoresisitive, Optical displacement sensor fiber optic sensor, Ultrasonic distance Sensor,Piezoresistive, Linear encoder, Proximity sensors.

Rotational Displacement: Revolution counter, Resistive potentiometers, RVDT, DC tachometer, AC tachometer, optical tachometer, Rotary encoder, eddy current , drag cup type tachometer, magnetic, stroboscope, gyroscope.

Unit II:

Force, Torque measurement

Force: Standards and Calibration, Basic methods of force measurement (Spring, beam, diaphragm) Strain gauge: basic principal, gauge factor, types of strain gauge, materials and their properties, bonding material compensation techniques, bridge configuration, Rosettes, Tactile sensors, Piezoelectric sensors, LVDT as secondary sensor

Torque: Torsion Bar, Flat Spiral Spring, Magenetostrictive Torsion Transducer, Dynamometers.

Unit III:

Pressure Measurement

Standards and calibration Units and relations.

Positive Pressure Sensors

Manometers – U tube, Well type, inclined tube, Ring balance, Micro manometer, use of seal pots, range of measurement

Elastic – Bourdon, Diaphragm, Bellows and their types, materials and their properties, range of measurement

Electronic – LVDT, Strain gauge, Capacitive, Piezoelectric, Thin film, Variable reluctance, Vibrating element (Diaphragm and Wire),

High Pressure Measurement – Bulk modulus cell, Bridgeman type

Differential Pressure Measurement: Force balance, Motion balance, Capacitance delta cell, Ring balance DP cell.

Vacuum measurement

McLeod gauge, Thermal Conductivity (Pirani, Thermocouple), hot cathode ionization gauge, Molecular momentum (Knudsen) gauge, Cold Cathode ionization (Penning) gauge.

Calibrating Instruments – Dead Weight Tester (Pressure, Vacuum).

Unit IV: Temperature measurement

Temperature Scales, Standards and Units and relations, Classification of temperature sensors

Mechanical: Bimetallic Thermometer – Working Principle, Various types, Filled system thermometers – SAMA classifications, Sources of errors and their remedies, Dip effect

Electrical: Resistance Temperature Detectors – Principle, materials and their properties, Types and ranges, different sources of errors and compensations

Thermistor: Types (NTC, PTC), Measuring Circuits

Thermocouple: Terminology, Types (B, E, J, K, R, S, T), determination of polarity, Characteristics, Laws of thermoelectricity, Study of thermocouple tables (calculation of intermediate temperature and voltage), Lead wire compensation, Cold junction compensation techniques, Protection (Thermo well), EMF Measurement methods, Thermopiles

Non-contact Types: Pyrometers: Total Optical, Infrared

Unit V: Flow Measurement

Units, Newtonian and non-Newtonian Fluids, Reynolds number, Laminar and turbulent flows, Velocity profile, Bernoulli's equation for incompressible flow, Density, Beta ratio, Reynolds number correction, Square root relation

Head type flow meters : Orifice (Eccentric , segmental , concentric) , Different pressure taps, Venturi, Flow nozzle, Dahl tube, Pitot tube, Annu bar, Characteristics of head type flow meters

Variable area type: Rotameter

Open channel flow measurement: Notch, Weirs

Turbine , Target , Electromagnetic , Ultrasonic (Doppler , Transit time i.e. Cross correlation) , Vortex shedding , Positive displacement , Anemometers (Hot wire, Laser)

Mass flow meters: Coriolis, Angular momentum, Thermal.

Unit VI: Miscellaneous Measurement

A) Level Measurement: Float, Displacer (Torque tube unit), Bubbler, Diaphragm box, DP cell, Ultrasonic, Capacitive, Radioactive, Resistance, Thermal,

B) Density Measurement: Chain-balanced float type, Hydrometer (Buoyancy type), U tube type, Hydrostatic Head (Air bubbler, DP Cell), Oscillating Coriolis.

Viscosity: Saybolt, Searle's rotating cylinder, Cone and plate, Falling and rolling ball, Rotameter

pH: Nearnst equation, Temperature compensation, Reference electrode, Measuring electrodes , Combined electrode, Maintenance and cleaners ,

Conductivity measurement: Probes, Cell constant, measuring circuits.

List of Experiments:

1. Calibration of pressure gauge using dead weight pressure tester and preparation of report for the same,.
2. Characterization of strain gauge indicator and weight measurement using load cell.
3. Measurement of displacement using LVDT
4. Study of linear and rotary encoder as displacement sensor.
5. Measurement of Pressure using Bellows, Bourdon gauge, Diaphragm.
6. Calibration of positive pressure gauges using Dead weight tester.
7. Calibration of vacuum gauge using vacuum gauge tester and preparation of the report.
8. Characterization of Thermocouples (J/T/K/R/S)
9. Characterization of RTD (PT100)
10. Measurement of flow Orifice and Venturi.
11. Level measurement using capacitive/ resistive/ air purge method.
12. Calibration of Rotameter.
13. Measurement of flow using DP cell

Text Books :

Measurement SystemApplication and Design- E. O. DoebelinMcGrawhill International- Fourth Edition

1. Principles of Industrial Instrumentation- D. Patranabis-Tata McGrawhill-7th Reprint,1986
2. Mechanical and Industrial Measurement- R.K.Jain- Khanna Publications-9th print
3. Process Control Instrumentation Technology- C. D. Jonhson- PHI-Seventh Edition
4. Electrical and Electronic Measurements and Instrumentation- A. K. Sawhney- DhanpatRai and Sons ,
5. Transducers and Instrumentation- D. V. S. Murthy- PHI-Second Reprint1995

Reference Books :

1. Process Measurement and Analysis- B. G. Liptak- Butterworth Heinemann- Third Edition

2. Jone’s Instrument Technology (Vol. 1 and Vol. 2)- B. E. Noltingk EL / BS- Fourth Edition

[206262] Linear Integrated Circuits

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

Examination Scheme:
Paper: 100 Marks
Practicals: 50 Marks

Unit I: Operational amplifier(Op-amp.) Fundamentals

Characteristics of Operational amplifier, Noise figure, types of Noise, Causes of Slew rate, Frequency response, Measurement of Slew rate (SR), Common Mode Rejection Ratio (CMRR), Power Supply Rejection ratio (PSRR/SVRR), Offset nullification techniques, comparative study of different amplifiers (LM741,LM324,OP07)

Unit II: Effect of Feedback in Op- Amplifier:

Introduction to feedback amplifiers, Voltage series feedback, (Non-inverting amplifier with feedback), deriving close loop gain , Voltage follower and it's applications, Voltage shunt feedback (Inverting simplifier with feedback), deriving close loop gain, Study of differential amplifier.

Unit III: Linear applications of Op- amplifier with practical considerations:

Voltage summing with average, Voltage subtracter, Current booster, Integrator, and practical integrator, Differentiator and practical differentiator, Instrumentation amplifier, with three Op-amps, Current to Voltage , voltage to current converter (grounded and floating load), Isolation amplifiers, chopper stabilized amplifiers, Equation solving with Op-amp.

Unit IV: Non linear applications with practical considerations:

Comparator characteristics, Zero Crossing Detector (ZCD) and it's use, Schmitt trigger with external bias, window detector, Precision half wave and full wave rectifiers, Sine wave oscillators using op-amp.: Barkhausen criteria, Wein bridge oscillator, RC phase shift oscillator. Study of IC-LM311

Unit V: Timers and Voltage regulators:

Design and applications of Multivibrators,Astable, Monostable (Re-triggerable and Non-retriggerable), Bi-stable using IC- LM555, Voltage regulators: Linear and DC voltage

regulators, basics of switching regulator: Voltage and current waveforms, basics of step-down switching regulator.

Unit VI: Active filters:

Butterworth approximations, Low pass (LP), High pass (HP), Band pass, Narrow band pass, Band reject, Notch filter, First and second order filters, (Design of LP and HP filter), Difference between active and passive filters and their merits and demerits. Filter terminology: Pass band, Stop band, Cutoff, Ripple, Q and order of the filter.

List of experiments:

Any eight experiments should be performed from following list:

1. Wein bridge oscillator
2. Instrumentation amplifier using LM324
3. Measurement of CMRR, Slew rate and offset.
4. Band width measurement of Inverting and Non-inverting amplifier
5. Designing and implementation of Integrator
6. Designing and implementation of Differentiator
7. Butterworth filter design and realization
8. Comparator, Schmitt trigger and Zero Crossing Detector
9. Voltage regulators: linear variable regulator LM723
10. Measurement of performance of 78xx regulator
11. Design of Astablemultivibrator using LM555
12. Design of Mono-stable multivibrator using LM555

Text Books:

1. RamakantGaikwad, " Operational Amplifiers" PHI, 3rd ed., 1992
2. William D. Stanley, "Operational Amplifiers With Linear Integrated Circuits", 4th ed., Pearson Education India, 2002.

Reference Books:

1. Paul Horowitz, Winfield Hill, "*The Art of Electronics*", 2nd Ed., Cambridge University press, 2008.

[206263] Basic Instrumentation

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

Examination Scheme:
Theory:100 Marks
Oral:50 Marks

Unit I: Introduction

Static and Dynamic characteristics of instruments, dead zone, hysteresis, threshold, resolution, input & output impedance, loading effects, fundamentals of measurements, Types of Error, Statistical Analysis, Probability of Errors, Limiting Errors , calibration of instruments, traceability, calibration report & certification.

Unit II: Analog Indicating Instruments

DC galvanometer, PMMC and Moving Iron instruments, voltmeters, ammeters, ohmmeters, multimeters and extension of range of instruments, AC indicating instruments, Potential and current transformers, wattmeters, energy meters, DC Potentiometers, self-balancing potentiometers, standardization, application

Unit III: Bridge Circuits

DC bridges: Wheatstone bridge and Kelvin bridge design, bridge sensitivity, errors in bridge circuits, null type and deflection type bridges, current sensitive and voltage sensitive bridges, applications of DC bridges

AC bridges: General equations for bridge balance, Maxwell bridge, Hey bridge, Schering bridge, Wein bridge, phasor diagrams, storage and dissipation factor, applications of AC bridges

Unit IV: Oscilloscope

Introduction, Oscilloscope Block Diagram, Cathode Ray Tube, CRT Circuits, Vertical Deflection System, Delay Line, Multiple Trace, Horizontal Deflection System, front panel controls, deflection sensitivity, dual trace CRO, Oscilloscope Probes ,measurement of electrical parameters like voltage, current, frequency, phase, Z-modulation, Digital Storage Oscilloscope

Unit V: Digital Instruments

Block diagram, principle of operation, Accuracy of measurement Digital Multimeter, Kilo Watt Hour meter, Phase meter, Digital Tachometer, Ultrasonic Distance meter, Digital Thermometer

Unit VI: Recording Instruments and Waveform Generation

Principle and working of strip chart and X-Y recorders, single and multi-channel recorders, driving systems for pen and chart, chart speed and their applications, Waveform generation methods, Function generator, Virtual Instrumentation

Text and reference books:

1. Electrical and Electronics Measurements and Instruments ,Sahwaney A K

2. W. D. Cooper & A. D. Helfrick, *'Electronic Instrumentation And Measurement Techniques'*, PHI,4th e/d, 1987

3. David Bell, *'Electronic Instrumentation and Measurements'*, PHI, 2e/d,

4. Anand M. M. S., *'Electronic Instruments and Instrumentation Technology'*,PHI, 2004

5. Kalsi H. S., '*Electronic Instrumentation'*, TMH, 2nd e/d, 2004

6. R. Subburaj, *'The foundation for ISO 9000 and TQM'*,

7. Bouwens A. J., *'Digital Instrumentation'*

List of Experiments (Students are expected to perform minimum 8 experiments.)

1. Design of multirange ammeter and voltmeter, conversion of ammeter into voltmeter.
2. Design of series and shunt type ohmmeter.
3. Design of Wheastone's Bridge.
4. Design of AC Bridge.
5. Measurement of unknown voltage using D.C. potentiometer.
6. Measurement of power using wattmeter (Single phase)
7. Measurement of power using Energymeter (Single phase.)
8. Measurement of voltage, Frequency and phase using CRO, measurement of unknown frequency by Z-Modulation.
9. To measure the unknown frequency by Z-Modulation.
10. Study of y-t, X-Y recorders, frequency response of y-t recorder

[206264] Photonics and Instrumentation

Teaching Scheme: **Examination Scheme:**

Lecture: 4 hrs per week Theory: 100 marks

UnitI: Fundamentals of light

Nature of light, electromagnetic optics spectrum, propagation of light, electromagnetic waves in dielectric media, polarization and coherence, interactions of light with matter, absorption, scattering, dispersion, polarization, diffraction and interference.

UnitII: Optical sources

Electromagnetic spectrum, types of spectra- line, band and continuous light sources, radiometry and photometry, natural sources, incandescent lamp, gas discharge lamp. Light-emitting diodes- electro luminescent process, choice of LED materials, LED structures, infrared sources, semiconductor laser

Unit III: Optical detectors

Thermal detectors and Quantum detectors, bolo meter, Photodiodes- PIN and avalanche photodiodes, phototransistors, photo multipliers, photo voltaic, IR detectors, Solar cells, CCD devices.

Unit IV: Optical components

Filters- absorption filters and interference filter, gratings- equation of diffraction grating, resolving power, concave grating, volume diffraction grating, holographic grating. Lenses, Polarizer and Beam splitters, Monochromator

Unit V: Fiber Optics

Wave guiding principles, dielectric waveguide, total internal reflection, evanescent wave, acceptance angle, numerical aperture, skew rays, single mode fibers, types and classification of

fibers, Attenuation, Material absorption losses, scattering losses, bending losses, intramodal and intermodal losses.

Unit VI: Optical instruments

Eye, telescopes, microscopes, optical projection systems, cameras, basic principles of Holography, OTDR, polarimeter.

Textbooks and references:

1. J. Wilson, Optoelectronics, Prentice-Hall of India.
2. Pallab Bhattacharya, 'Semiconductor Optoelectronic Devices', Second Edition, Pearson Education, 1997.
3. Eugune Hecht, A.R. Ganesan, 'Optics', Fourth Edition, Person Education, 2008.
4. John M. Senior, Optical Fiber Communications, Prentice Hall of India,3rd edition.
5. Harold Kolimbiris, 'Fiber Optics Communications', Pearson Education, 2004.

[206265] Data Structures and Files

Teaching Scheme:
Tutorial: 1 Hr/batch
Practical: 2Hrs/batch

Examination Scheme:
TW-50 Marks

Learning Objectives:

1. To describe the usage of various data structures.
2. To design and apply appropriate data structure for solving computing problems.
3. To possess the ability to design simple algorithms for solving computing problems.
4. To think critically and solve problems independently.

Prerequisite:

Data types, conditional, arithmetic operators, input/output functions, for, while, do-while, basics of arrays and functions.

Unit-I: Applications of Arrays and Functions

Applications of Arrays and Functions (Passing parameter by value and recursive functions) in C for Searching and Sorting Methods.

Searching Methods: Sequential and Binary Search.

Sorting Methods-Selection sort, bubbles sort, Insertions sort.

Unit-II: Pointers, Structures, and Unions

Pointers in C: Basic concept, Arrays & Pointers (Static and dynamic allocation), Functions & Pointers (Passing by reference) , Structures in C , Array of structures, passing structure to function, structures and pointers, Unions, Concept of ordered list & polynomial representation using array of structures.

Unit-III: Singly and Doubly linked list

Concept of data structure, Abstract data type, Singly linked list (SLL), Doubly Linked List (DLL) and operations (create, insert, delete, search).

Unit-IV: Stacks and Queues

Representation of Stacks and Queues Using array and linked list.

Unit-V: Trees

Non-linear data structure: Basic terminologies, Binary trees, binary search tree representation, BST traversals, and Primitive operations on BST: Create, insert, delete. Binary Trees: Create insert and traversals operations.

Unit-VI: Files

Basics of files, queries, sequential organization, and index techniques.

Text Books:

1. Ellis Horowitz and SartajSahni, Fundamentals of Data Structures, GlgotialBooksources
2. YedidyahLangsam, Moshe Augesten, Aaron M Tannenbaum-Data Structures using C and C++-PHI publications (2nd Edition)

Reference Books:

1. M.A. Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Addison-Wesley, 1997.
2. E Balgurusamy - Programming in ANSI C, Tata McGraw-Hill (Third Edition)

List of Experiments (All the experiments are compulsory)

1. Program for Linear & Binary Search methods using Arrays and Functions in C
2. Program for Bubble, Selection, Insertion Sorting methods using Arrays and Functions in C.
3. Program for polynomial addition and database management using array of structure.
4. Program for Implementation of singly linked list- Create, Insert, Delete, Search operations.
5. Implementation of stack using arrays.
6. Implementation of stack using Linked List.
7. Implementation of Queue using array.
8. Implementation of Queue using Linked List.
9. Implementation of Binary search tree: Create, search, recursive traversals.

[206266] Transducer and Signal Conditioning

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

Examination Scheme:
Paper: 100 Marks
Practicals: 50 Marks

Unit I: Principles of analog and digital signal conditioning

a. Introduction, signal level and bias changes, linearization, conversation faltering and impedance matching, concept of loading, divider circuits, bridge circuits, lead compensation, RC filters (low pass, high pass), Readout/ meter.
b. Introduction, application of Boolean algebra, Converters (comparators, DAC, ADC), Readout/display

Unit II: signal conditioning for resistive sensors :

Temperature sensor (RTD, Thermister), load cell, potentiometric sensors, Basic characteristics (principle, linearity, range, power rating and losses), excitation techniques (constant power, current, bridge), detectors and converters (resistance to Current, resistance to voltage, resistance to frequency, resistance to time)

Unit III: signal conditioning for capacitive sensors :

Level sensor, displacement sensor, proximity detector, humidity sensor, differential pressure cell, Basic characteristics (principle, linearity, range), excitation techniques (constant voltage/current, bridge), detectors and converters (impedance matching, capacitance to frequency, capacitance to time, capacitance to voltage)

Unit IV: signal conditioning for inductive sensors :

Displacement transducer (LVDT/RVDT), proximity detector, inductive pick-up, Basic characteristics (principle, linearity, range), excitation techniques, detectors and converters (phase sensitive detector/rectifier, wave shaper)

Unit V: signal conditioning for optical devices:

LEDs, Photo diode, Light Dependant Resistance(LDR), PIN diode, photo transistor, photo cell, optical proximity switch (through beam, reflected beam), optical encoders (incremental,

Absolute), stroboscope, pyrometer, Basic characteristics of optical source and detector, excitation techniques (constant voltage/current, modulated beam) detectors and converters (Current to voltage converter, wave shaper, direction and position detection for encoder)

Unit VI: signal conditioning schemes for following devices:

Temperature indicator using Thermocouple with cold junction compensation, Charge amplifier for piezoelectric sensor, ultrasonic detector for displacement, level(single and multiple liquid), pH and conductivity measurement, Hall sensor, Electromagnetic flow meter.

List of experiments:(Any six experiments should be performed from following list)

1. Design and implementation of electronic thermometer using PT100
2. Design and implementation of temperature indicator using thermocouple with cold junction compensation technique
3. Design and implementation of weighing machine using load cell
4. Design and implementation of liquid level indicator using electromechanical system.
5. Design and implementation of liquid level indicator using capacitive transducer.
6. Design and implementation of digital control logic for process using electronic hardware / software.
7. Demonstration and characterization of stroboscope.
8. Design and implementation of through beam / reflected beam type optical proximity switch.
9. Design and implementation of signal conditioning scheme for position and/or direction detection for optical encoder.
10. Design and implementation of signal conditioning scheme for displacement measurement using LVDT.

Text Books:

1. Curtis D. Johnson, "*Process control instrumentation technology*" 8th ed. PHI learning Pvt. Ltd.,2010.

2. Thomas G. Beckwith, John H. Lienhard V, Roy D. Marangoni, "*Mechanical measurements*" 6th ed., Pearson Prentice Hall, 2012.
3. Andrew Parr, "*Industrial Control hand book*", 3rd ed., Newnes Industrial Press, 2000

Reference Books:

1. Paul Horowitz, Winfield Hill, "*The Art of Electronics*", 2nd Ed., Cambridge University press, 2008.
2. Andrew Parr, "*Industrial Control hand book*", 3rd ed., Newnes Industrial Press, 2000
3. Walt Kester, "*Practical Design Techniques for Sensor Signal*" Analog Devices, Inc.,1999
4. John G. Webster, "*Sensors and signal conditioning*" 2nd ed. Wiley-Interscience Publication,2001.

[206267] Electronic Instrumentation

Teaching scheme:
Lectures: 4/week
Practical: 2/batch

Examination scheme:
Paper: 100 Marks
TW: 50 Marks

Unit I:

Measuring Instruments: RMS And True RMS Measurement, DMM, R L C - Q Meter, Basic and Continuous Count Counter,Universal Counter and Its Mode like Totalizing, Frequency, Period, Time Interval, Ratio, Measurement Errors in counter, Application of Counters For Low and High Frequency Measurement,RTXO,TCXO.

Unit II:

Ramp Wave generator, Pulse generator, Sine wave synthesis, Arbitrary Waveform Generator,Semiconductor Test Instrumentation(PMU and PE).

Unit III:

Oscilloscope: Sweep Modes of Dual Trace Oscilloscope, Active and Passive Probes, Delay Line, Digital Storage Oscilloscope and Its Modes like Roll, Refresh,Pre-trigger,Post-trigger and Sampling Rate, Application of the same in Instrumentation and Measurement, Introduction to Mixed Oscilloscope

Unit IV:

Sampling Theorem, Sample and Hold Circuit, ADC and DAC Specifications,ADC Quantization Error, ADC types like Flash,Counter,SAR,Dual-Slope and Introduction to Delta-Sigma, DAC types like Weighted-Resistor,R-2R ladder and PWM type,ADC and DAC Problems, Data Logger.

Unit V:

Modulation techniques: Telemetry,AM,FM,ASK, FSK, Time Division and Frequency Division Multiplexing.Virtual Instrumentation:LabVIEWSoftware and Hardware,LabVIEW Application in Process/Biomedical or Electronic Instrumentation.

Unit VI:

Distortion Analyzer, Spectrum Analyzers,Waveanalyzers,Introduction to Network and Logic Analyzer, OTDR

List of Experiments:

Students are expected to perform Minimum 8 Experiments

1. Measurement of Bandwidth of X and Y amplifier of CRO -using Source and Rise time method

2. Study and Application of Universal Counter

3. Study of DSO - Measurement of Response time ofRelay using DSO

5. Study of ADC 0809 or Equivalent

6. Study of DAC 0808 or Equivalent

7. Study of Arbitrary Waveform Generator

8. Develop LabVIEW based DAQ Application (Any)

9. Study of R, L, C, Q meter

10. Study of Distortion Factor Meter/Logic Analyzer/Network Analyzer

Textbooks :

1. Electronic Instrumentation and Measurement Techniques byH. Cooper, PHl

2. Digital Instrumentation by A. J. Bowen

3. Electronic Instrumentation Handbook by Coombs.

4. Electronic Instrumentation by Oliver Cage, McGraw Hill.

5. ElectronicInstrumentation by J. J. Carr.

6. Electrical and Electronic Measurements and Instrumentation by David A. Bell

7. Electrical and Electronics Measurement and Instrumentation by A.K. Sawhney

8. Electronic Instruments and Instrumentation Technology by Anand M. M. S.

[206268] Automatic Control System

Teaching scheme:
Lectures: 4/week
Practical: 2/batch

Examination scheme:
Paper: 100 Marks
Oral: 50 Marks

Objectives:

- To introduce the mathematical modeling of physical systems through the concepts of transfer function.
- To understand the concept of linear dynamic systems, invariant in time and its representation through its transfer function.
- To determine the characteristics that may hold the responses to the first and second order systems where standard inputs (impulse, step or ramp) are applied.
- To understand the advantages of closed loop systems.
- To provide the basis for an intuitive understanding of how control can change the behavior of physical systems.
- To be able to simulate the behavior of LTI systems using MATLAB.

Unit-1 Introduction to Control Systems

Introduction, brief classification of control systems: Open loop v/s closed loop, feedback v/s feedforward, linear v/s nonlinear, stable v/s unstable, time invariant v/s time variant, causal v/s non-causal, SISO v/s MIMO systems (definitions only), Mathematical Modeling of systems, Laplace transform and its applications, transfer function & its properties, Role of LTI systems in control systems

Unit-2: Representation of systems

Representation of electrical, mechanical, electromechanical, thermal, pneumatic, hydraulic systems, force to voltage and force to current analogies. Block diagram algebra: Rules of block diagram reduction and determination of overall transfer function, Signal flow graph: Mason gain formula and its use to determine the overall transfer function, Conversion of block diagram to signal flow graph.

Unit-3: Time domain analysis of control systems

Standard test signals: impulse, step, ramp, sinusoidal, complex exponential, impulse response of a control system (from transfer function using inverse Laplace transform), Concept of pole, zero, order and type of a control system, first order , second order systems and their response to impulse and step inputs (for second order systems treat un damped, critically damped, under damped and over damped cases separately), time domain specifications of first order control systems from step response (first five time constants), time domain specifications of second order control systems from step response (natural frequency, damping factor, damped frequency,

delay time, rise time, peak time, peak overshoot, settling time for 2% and 5% settling –derivation is expected), static error constants (kp, kv, ka, ess),dynamic error constants.

Unit-4: Stability and Root Locus

A] Concept of Stability in s domain : Classification of Stability (BIBO stability and asymptotic stability), pole- zero plots in s domain, response term contributed by different types of poles, stability analysis by Hurwitz criterion and Routh array, determination of marginal gain and oscillation frequency using Routh array, concept of relative stability and its analysis using Routh array.

B] Root locus: definition, magnitude and angle conditions, construction rules, determination of system gain at any point on root locus (from magnitude condition and by graphical method), root locus of systems with dead time: Concept, approximation of dead time and construction rules.

Unit-5: Frequency Domain Analysis and Stability

A] Frequency domain analysis of control systems: Response of control systems to sinusoidal inputs, frequency domain specifications of a second order system (resonant frequency, resonant peak), correlation between time domain and frequency domain specifications.

B] Stability analysis in frequency domain using Bode plot: Bode plot, Actual Bode plot and asymptotic Bode plot, Concept of gain margin, phase margin and bandwidth, stability analysis, Bode plot of systems with dead time, Determination of transfer function from asymptotic Bode plot

Unit-6: Polar plot and stability analysis in frequency domain using Nyquist plot

Polar plot: Concept and construction, Nyquist plot: mapping theorem, Nyquist stability criterion, Nyquist plot, and special case of Nyquist plot for systems with pole or zero at origin, stability analysis.

Text books:

1. I. J. Nagrath, M. Gopal, “Control System Engineering”, 3rd ed., New Age International Publishers, 1999.

2. B. S. Manke, “Linear Control Systems”, 8th ed., Khanna Publishers, New Delhi, 2007.

3. A. K. Jairath, “Problems and Solutions of Control Systems”, 4th ed. CBS Publishes, New Delhi, 2004.

Reference books:

1. K. Ogata, “Modern Control Engineering”, 2nd ed., PHI, New Delhi, 1994.

2. Norman S. Nise, “Control System Engineering”, 4th ed., John Wiley and Sons, 2003.

3. B. C. Kuo, “Automatic Control Systems”, 3rd ed., PHI, New Delhi, 1979

List of experiments: (First and Sixth experiment is compulsory. Students are expected to perform experiments in laboratory on any small electrical circuit and then same results can be verified using MATLAB for the remaining experiments)

1. Introduction to MATLAB and control system toolbox.

2. Obtaining transfer function, transient response and time domain parameters of second order electrical circuit (RLC series network) and compare the results with theoretical values and simulate the experiment using MATLAB.

3. Sketch the root locus for a given system and determine the system gain for a particular value of damping factor. Also simulate the same using MATLAB.

4. Sketch the Bode plot (actual and asymptotic) for a given system and analyse the stability. Also simulate the same using MATLAB.

5. Sketch the Nyquist plot for a given system and analyse the stability. Also simulate the same using MATLAB.

6. Case study of any control system with all the parameters like its transfer function, poles, zeros, stability etc

[206269] Digital Techniques

Teaching Scheme:
Lecture: 4 hrs./week.
Practical: 2 hrs./week

Examination Scheme:
Theory : 100 marks
Practical: 50 marks

Prerequisites: Basic Electronics Engineering

Learning Objectives

1. To learn and understand basic digital design techniques.

2. To learn and understand design and construction of combinational and Sequential circuits.

3. To introduce basic components of microprocessors

4. To understand Practical applications of digital electronics

UnitI :Number System & Logic Design Minimization Techniques

Introduction: Binary, Hexadecimal numbers, octal numbers ,number conversion and their arithmetic

Signed Binary number representation: Signed Magnitude, 1's complement and 2's Complement representation.

Binary, Octal, Hexadecimal Arithmetic: 2's complement arithmetic.

Codes : BCD, Excess-3, Gray code , Error detecting & correcting Codes, ASCII Code and code conversions., BCD Arithmetic

Boolean algebra: Truth tables and Boolean algebra. Idealized logic gates and symbols. DeMorgan's rules Axiomatic definition of Boolean algebra, Basic theorems and properties of Boolean algebra

Logic minimization: Representation of truth-table, SOP form, POS form,Simplification of logical functions, Minimization of SOP and POS forms, Don't careConditions

Reduction techniques: K-Maps up to 4 variables and Quine-McClusky techniques

Unit II: Logic Families

Standard characteristics: Speed, power dissipation, fan-in, fan-out, current and voltage parameters, noise margin, operating temperature etc.

ECL,NMOS,PMOS families : Basic circuits, Standard characteristics.

TTL: Standard TTL characteristics, Operation of TTL NAND gate. TTL Configurations- Active pull-up, Wired AND, totem pole, open collector.

CMOS: CMOS Inverter, CMOS characteristics, CMOS configurations- Wired Logic, Open drain outputs

Detail comparison of TTL & CMOS

Interfacing: TTL to CMOS and CMOS to TTL,Tristate Logic

UnitIII :CombinationalLogic

Circuits: - Half- Adder, Full Adder, Half Subtract or, Full Subtractor, BCD adder, look ahead and carry, parity generator and checker , magnitude comparator ,code convertors

Deocoders- Working of decoder, implementation of expressions using decoders ,IC 74138 , BCD to 7 segment decoder circuits , BCD to 7 segment decoder/driver IC 7448/7447

Encoders - working of encoders, priority encoders, IC 74148

Multiplexers (MUX):- Working of MUX, Implementation of expression using MUX (IC 74153, 74151).

Demultiplexers (DEMUX):- Working of DeMUX, Implementation of expression using DEMUX

Unit IV: Sequential Logic

Introduction: Sequential Circuits. Difference between combinational circuits and Sequential circuits

Flip- flop: SR, JK, D, T; Preset & Clear, Master and Slave Flip Flops their truth tables and excitation tables, Conversion from one type to another type of Flip Flop.

Application of Flip-flops: Bounce Elimination Switch

Registers: Buffer register; shift register; IC 7495

Counters: definition of Modulus of counter**,** Asynchronous counters. Synchronous counters, state diagram representation, Design of Synchronous counters, Presettable and programmable counters, Decade/BCD counters, ring and Johnson counters, Divide by N counter, timing diagram of counters, Realization of counters using ICs 7490, 7492,7493 and 74193

Sequence Generator: using shift registers and counters

Unit V: PLDs & Introduction to Microprocessor

PLD: PLA- Input, Output Buffers, AND, OR, Invert/ Non-Invert Matrix.

Design Example: Any 4 Variables SOP function using PLDs, Study of basic Architecture of FPGA and CPLD

Introduction to Microprocessor: Introduction of Ideal Microprocessor, Data Bus, Address Bus, Control Bus, Microprocessor Based System- Basic Operation, Microprocessor Operation, 8085 Microprocessor Architecture

Unit VI: Applications of Digital circuits & Memory

Applications of digital circuits: Digital Clock, Frequency counter, Stepper motor sequence generator, Alarm announciator.

Memory : RAM, ROM, EPROM, E^2 PROM, Flash Memory, bubble memory, CD ROM

List of experiments (Perform any 8 experiments)

1. Code Conversion
2. Design and Implementation of full adder and subtractor using logic gates.
3. Study of Multiplexer IC 74151
4. Study of Flip –Flop ICs and conversion of flip –flop from one other
5. Implementation of counter of different Mod numbers using 7490 & 7493 ICs
6. Design of Non sequential counter using flip –flop using ICs 7476,7474
7. Design Ring & Johnson counters using shift register IC 7495
8. Interfacing of 7 segment LED display using IC 7447
9. Study of Presettable Up / Down counter using IC 74193
10. Interfacing of TTL and CMOS ICs

Note: Use of digital breadboards is mandatory

Text Books

1. Malvino and leach , " Digital Principals & Applications", 4th Edition, TMH
2. Flyod "Digital Principles", Pearson Education
3. Microprocessor Architecture Programming and Applications with 8085 – R.S. Gaonkar

Reference Books

1. Thomas Floyd, ‘Digital fundamentals’- , Universal Book Stall, third Edition

2. M. Morris Mano,’ Digital Design’, Pearson Education Asia, 3rd Edition

[206270] Industrial Drives

Teaching Scheme:
Lectures: 3 hrs./week

Examination Scheme:
Theory:100 Marks

Objective: To study the different motors used in industry and their driving circuits.

Unit 1: Introduction to Power devices

Construction, Working, Characteristics, Specifications and applications of SCR,TRIAC, DIAC, Power MOSFET,IGBT and UJT.SCR gatetriggering and commutation circuits.Series and parallel connection of SCR and itstriggering arrangement.

Choppers: Principle, Working, Classification, Thyristorised Choppers- Jones Chopper, Morgan Chopper

Unit 2: Converters, Inverters

Single Phase and Three Phase Controlled rectifiers, (Half wave, full wave and bridge configuration) with resistive and Inductive Load. Invertors and choppers, Single-phase rectifiers and single phase controlled

Inverters: Classification, Single Phase half bridge and full bridge Inverters, PWM Inverters

Unit 3: DC Machines

DC generator, working principle, construction feature, types, emf equation, characteristics

DCmotors, types, motoring action, torque equation for DC motor, characteristics of DC motor, Back EMF in DC motor, conventional speed control of DC motors

Mathematical model of DC motor, Transfer function of field controlled and armature controlled DC motor, DC motor Starters and applications.

Unit 4: AC Machines

Induction motors (3 phase): Concept of rotatingmagnetic field, working principle, constructional feature, types, torque equation,torque slip characteristics, efficiency, types of starter, conventional method of speed control.

Closed Loop control,V/F control, controlledcurrent and controlled slip operation, Slip power recovery system.Braking of Induction Motor.

Unit 5: Special Purpose Machines I

Alternators: Working principle, construction,emf equation, Synchronousspeed of Alternators

Synchronous motors: Working Principle, Construction, adjustable frequencyoperation of synchronous motors, speed control.

Single Phase Induction motors: Working principle, construction, types, application and characteristics

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Unit 6: Special purpose Machines II

Stepper motor:Working principle, construction, types, application and characteristics. Half and full step sequence, driving circuit using L297, L298

Servo motor:Working principle, construction, types, application and characteristics

Universal Motor:Working principle, construction, types, application and characteristics

Reference books

1. P. C. Sen,' *Power Electronics'*, TMH, 2007
2. MD Singh, K B Khanchandani, 'Power Electronics', 2nd edition, McGraw Hill Company
3. Mohamad Rashid,' *Power Electronics'*, PHI, 2nd e/d, 2004
4. G.K.Dubey, Power semiconductor controlled drives, Prentice Hall- 1989
5. B. L. Thareja, *Electrical machines Vol II'*, S. chand& Suns, 2009
6. Krishnan, Electrical Motor Drives, PHI-2003

[206271] Communication Skill

Teaching Scheme
Tutorial: 01Hrs/ Week
Practical: 2 hrs./week

Examination Scheme
TW– 50 marks

UNIT I: (04 hours)

Self Awareness & self Development –

a) Self Assessment , Self Appraisal, SWOT, Goal setting - Personal & career - Self-Assessment, Self-Awareness, Perceptions and Attitudes, Positive Attitude, Values and Belief Systems, Self-Esteem, Self appraisal, Personal Goal setting,

b) Career Planning, Personal success factors, Handling failure, Depression and Habit, relating SWOT analysis & goal setting, prioritization.

UNIT II: Communication Skill (06 hours)

a) Importance of communication, types, barriers of communication, effective communication

b) Speaking Skills – Public Speaking, Presentation skills, Group discussion- Importance of speaking effectively, speech process, message, audience, speech style, feedback, conversation and oral skills, fluency and self expression, body language phonetics and spoken English, speaking techniques, word stress, correct stress patterns, voice quality, correct tone, types of tones, positive image projection techniques.

c) Listening Skills: Law of nature- you have 2 ears and 1 tongue so listen twice and speak once is the best policy, Empathic listening, Avoid selective listening-

d) Group Discussion - characteristics, subject knowledge, oral and leadership skills, team management, strategies and individual contribution and consistency.

e) Presentation skills - planning, preparation, organization, delivery.

f) Written Skills – Formal & Informal letter writing, Report writing, Resume writing - Sentence structure, sentence coherence, emphasis. Paragraph writing. letter writing skills - form and structure, style and tone. Inquiry letters, Instruction letters, complaint letters,
Routine business letters, Sales Letters etc.

UNIT III: Corporate / Business Etiquettes (02 hours)

Corporate grooming & dressing, Email & telephone etiquettes, etiquettes in social & office setting-Understand the importance of professional behaviour at the work place, Understand and Implement etiquettes in workplace, presenting oneself with finesse and making others comfortable in a business setting. Importance of first impression, Grooming, Wardrobe, Body language, Meeting etiquettes (targeted at young professionals who are just entering business environment) , Introduction to Ethics in engineering and ethical reasoning, rights and responsibilities,

UNIT IV: Interpersonal relationship (04 hours)

a) Team work, Team effectiveness, Group discussion, Decision making - Team Communication. Team, Conflict Resolution, Team Goal Setting, Team Motivation

Understanding Team Development, Team Problem Solving, Building the team dynamics. Multicultural team activity

b) Group Discussion- Preparation for a GD, Introduction and definitions of a GD, Purpose of a GD, Types of GD, Strategies in a GD , Conflict management, Do's and Don'ts in GD

UNIT V: Leadership skills (02 hours)

Leaders' role, responsibilities and skill required - Understanding good Leadership behaviours, Learning the difference between Leadership and Management, Gaining insight into your Patterns, Beliefs and Rules, Defining Qualities and Strengths of leadership, Determining how well you perceive what's going on around you, interpersonal Skills and Communication Skills, Learning about Commitment and How to Move Things Forward, Making Key Decisions, Handling Your and Other People's Stress, Empowering, Motivating and Inspiring Others, Leading by example, effective feedback

UNIT VI: Other skills (02 hours)

a) Time management- The Time management matrix, apply the Pareto Principle (80/20 Rule) to time management issues, to prioritise using decision matrices, to beat the most common time wasters, how to plan ahead, how to handle interruptions , to maximise your personal effectiveness, how to say "no" to time wasters, develop your own individualised plan of action

b) Stress management- understanding the stress & its impact, techniques of handling stress

c) Problem solving skill, Confidence building Problem solving skill, Confidence building

Term Work/Assignments

Term work will consist the record of any 8 assignments of following exercises

1. SWOT analysis
2. Personal & Career Goal setting – Short term & Long term
3 Presentation Skill
4. Letter/Application writing
5. Report writing
6. Listening skills
7. Group discussion
8. Resume writing
9. Public Speaking
10. Stress management
11. Team Activity-- Use of Language laboratory

*** Perform any 8 exercises out of above 11 with exercise no. 11 as compulsory.**

Teaching Methodology

Each class should be divided into three batches of 20-25 students each. The sessions should be activity based and should give students adequate opportunity to participate actively in each activity. Teachers and students must communicate only in English during the session.

Specific details about the teaching methodology have been explained in every activity given below.

Practical Assignments (Term work)

Minimum 8 assignments are compulsory and teachers must complete them during the practical sessions within the semester. The teacher should explain the topics mentioned in the syllabus during the practical sessions followed by the actual demonstration of the exercises. . Students will submit report of their exercise (minimum 8) assignments as their term work at the end of the semester but it should be noted that the teacher should assess their assignment as soon as an activity is conducted. The continual assessment process should be followed.

1. **SWOT analysis**

The students should be made aware of their goals, strengths and weaknesses, attitude, moral values, self confidence, etiquettes, non-verbal skills, achievements etc. through this activity. The teacher should explain to them on how to set goals, SWOT Analysis, Confidence improvement, values, positive attitude, positive thinking and self esteem. The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.

2. **Personal & Career Goal setting – Short term & Long term**

3 **Presentation Skills**

Students should make a presentation on any informative topic of their choice. The topic may be technical or non-technical. The teacher should guide them on effective presentation skills. Each student should make a presentation for at least 10 minutes.

4**. Letter/Application writing**

Each student will write one formal letter, and one application. The teacher should teach the students how to write the letter and application. The teacher should give proper format and layouts.

5. **Report writing**

The teacher should teach the students how to write report .. The teacher should give proper format and layouts. Each student will write one report based on visit / project / business proposal etc.

6**. Listening skills**

The batch can be divided into pairs. Each pair will be given an article (any topic) by the teacher. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students will be asked questions on the article by the readers. Students will get marks for correct answers and also for their reading skills. This will evaluate their reading and listening skills. The teacher should give them guidelines on improving their reading and listening skills. The teacher should also give passages on various topics to students for evaluating their reading comprehension.

7. **Group discussion**

Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback.

8. **Resume writing**

Each student will write one formal letter, and one application. The teacher should teach the students how to write the letter and application. The teacher should give proper format and layouts.

9. **Public Speaking**

Any one of the following activities may be conducted :

a. **Prepared speech** (topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver.
b. **Extempore speech (**students deliver speeches spontaneously for 5 minutes each on a given topic)
c. **Story telling (Each student narrates a fictional or real life story for 5 minutes each)**
d. **Oral review** (Each student orally presents a review on a story or a book read by them)

10.. **Team Activity**-- Use of Language laboratory

Text Books:

1 Communication Skills : Sanjay Kumar and Pushpa Lata , Oxford University Press
2 Developing Communication Skill : Krishna Mohan, Meera Banerji,- McMillan India Ltd.
3 English for Business Communication : Simon Sweeney , Cambridge University Press

Books for references:

1.NASSCOM-Global Business Foudation Skills: Accenture,Convergys,Dell et.al. Foundation Books : Cambridge University Press
2**.** Basic Managerial Skills for all E. H. McGrath, Eastern Economy Edition, Prentice hall India.
3. Personality Development and Group Discussions,Barun K. Mitra, Oxford University Press
4 Group Dissussions and Interview Skills : Priyadarshi Patnaik : Foundation Books : Cambridge University Press
5.Thinks and Grow Rich: Napoleon Hill, Ebury Publishing, ISBN 9781407029252
6. Awaken the Giant Within: Tony Robbins HarperCollins Publishers, ISBN-139780743409384
7. Change Your Thoughts, Change Your Life: Wayne Dyer, Hay House India, ISBN-139788189988050
8 Habits of Highly Effective People: Stephen Covey Pocket Books, ISBN-13 9781416502494
9The Power of Your Subconscious Mind: Dr Joseph Murphy Maanu Graphics , ISBN-13 9789381529560
10- The new Leaders: Daniel Coleman Sphere Books Ltd , ISBN-139780751533811
11 The 80/20 Principal: by Richard Koch, Nicholas Brealey Publishings ,

ISBN-13 9781857883992
12 Time management from inside out: Julie Morgenstern, Owl Books (NY),
ISBN-13 9780805075908
13.Wonderland of Indian Manageress: Sharu Ranganekar, Vikas Publishing Houses,
ISBN-13 9788125942603
14. You can win: Shiv Khera, Macmillan, ISBN-139789350591932
15. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success:
Gopalaswamy Ramesh, Mahadevan Ramesh