Solapur University, Solapur
M.Sc. ELECTRONICS SYLLABUS (REVISED)
(w.e.f. June 2010)

M.Sc. Electronics Part -I
Semester – I (Revised)

Paper No. I: Mathematical Techniques
Paper No. II: Instrumentation Design
Paper No. III: Power Electronics
Paper No. IV: Advanced Microcontrollers

M.Sc. ELECTRONICS SYLLABUS (REVISED)

M.Sc. Electronics Part -I
Semester – II (Revised)

Paper No. V: Control theory
Paper No. VI: Real time operation system
Paper No. VII: Opto Electronics
Paper No. VIII: Electronics Circuit design

M.Sc-I Semester -I
Paper-I: Mathematical Techniques

Unit-I Laplace Transform: 10

a) Introduction to Integral transform Laplace transform and its importance to study electrical circuits.
b) Laplace transform of standard functions, properties of Laplace transform, Laplace transform of periodic functions,
c) Inverse Laplace transform, Partial fraction rule.
d) Study of RL, RC, RLC circuits using Laplace transform.

Unit-II Fourier Series and Fourier Transforms 13

Periodic function, Fourier series, Fourier series in sine form only, Fourier series in cosine form only, determination of Fourier coefficient, wave symmetry choice of limit of integration and line spectrum, Exponential form of Fourier series, average and rms value of periodic complex wave , examples on rectifier, controlled rectifier, triangular and square waveforms.

Fourier Transform, periodic and non periodic signal representation, properties of Fourier transforms, Fourier transform of exponential function, gate function, unit impulse and step function.

Unit-III System of Linear Algebraic Equations: 12

a) Formulation of system of linear algebraic equations using matrix and vector notations. Matrix transformations, adjoint and co-factors, Determinant of matrix, Inverse of matrix, Identification of square, upper-triangular(U), lower triangular(L), tri-diagonal, ill-condition and sparse matrices.
b) **Direct methods :** Gauss Jordan elimination method, Gaussian Elimination method and LU factorization method . Introduction to Iterative method**.**
c) **Case Study** : Study of R-2R ladder network using tri-diagonal system

Unit-IV Curve Fitting 07

a) **Curve fitting :**Introduction to curve fitting. Empirical relation and actual relation.
b) **Least Squares method of curve fitting :** Straight line fitting, Second order polynomial fitting.
c) **Interpolation :** Difference between interpolation and extrapolation. Piecewise Linear interpolation, Newton's forward difference formula for interpolation , Newton's backward difference formula for interpolation, Cubic splines approximation. Divided differences for unequal intervals, Langrangian interpolating polynomials

Unit-V Numerical Differentiation and Integration 05

a) Numerical Differentiation : Introduction, Forward, central and backward formulae for differentiation,
b) Numerical Differentiation : Introduction, Newton-Cotes Quadrature formula, Trapezoidal rule, Simpson 1/3 rule and 3/8 rule of numerical integration..
c) **Case Study** : Study of RC differentiator and integrator circuits.

Unit-VI Solution of Ordinary Differentiation Equation 05

a) Introduction, Initial value problem and boundary value problem.
b) Taylor series method, Euler`s method , Runge Kutta method.

Reference Books:

1. Circuit and Network analysis and synthesis by A. Sudhakar and S. P. Shammohan 2nd Edition, TMH,
2. Numerical Method with programming in C 2nd Edition, by T. Veerarajan and T. Ramchandran, TMH, New Delhi.
3. Applied Numerical Methods for Engineer, using MATLAB and C, Robert J Schilling and Sandra L Harries, Thompson publishers, 1999.
4. Numerical Methods for scientific and Engineering computation by M. K. Jain, S. R. K. Iyengar and R. K. Jain 5th Edn. New Age International, New Delhi.
5. Computer Oriented Numerical Methods by V. Rajaraman.
6. Numerical method by E. Balgurusamy, TMH.

Paper-II: INSTRUMENTATION DESIGN

Unit 1: Transducer and its interfacing (14)

a) **Sensors:** Sensors and Transducers, Active and Passive sensors, characteristics of sensors, static and dynamic characteristics, Accuracy and precision, Linearity, hysteresis, loading effects, threshold and stiffness.
Thermocouples, Thermistors, RTD, PT 100, Semiconductor temperature transducers, AD590, LM35, LM135, LM235, LM335. Their types, characteristics, specifications. Designing of simple interfacing circuits.
Strain-gauge, load cell, piezo-electric, LVDT . Force, flow, level, displacement transducers, Designing of simple interfacing circuits.
Hall effect and IR transducers and their interfacing

b) **Actuators:** Electromagnetic relay, Limit switch, Proximity sensor, Inductive, Capacitive, IR proximity sensor.

Unit 2: Instrumentation: 15

a) General block diagram of instrument design for measurement. Minimum requirements, AC and DC bridges, Excitation, Grounding and electromagnetic and electrostatic shielding. Readout, Need of display system in instrumentation. Digital and Analog display, LCD (16 x 2 line), Recorders, plotters etc.

b) Signal conditioners, Designing of pre-amplifiers, Instrumentation and chopper Amplifiers, Instrumentation amplifier, Signal conditioner (2B30), Programmable Excitation device (2B35) Programmable instrumentation amplifier 2B31, AD524, AD620, AD594/595, Isolation amplifier (Model 289)

Unit 3:Signal transformation 10

Signal transmission, 4-20mA current, Characteristics of 4-20mA current loop, programmable 4-20mA current drivers. F-V & V-F, V-I & I-V converters.

Unit 4:Data acquisition system(DAS)

Need of DAS, Single channel data acquisition system, Multi-channel DAS, data loggers, basic Operation of data loggers, compact data loggers. Microcontroller based minimum system for data acquisition **(10)**

Unit 5:Case Studies

- Designing of instrumentation for measurement of
  a) Temperature
  b) Humidity
  c) Gas concentration
- Interfacing of PIR and ultrasonic sensor modules

Reference Books:

1. Transducer Interfacing Handbook- A guide to analog signal conditioning- Daniel H Sheingold, Analog Devices, Massachusetts
2. Electronic instruments –K.S.Kalsi, Tata MC-Graw Hill.
3. Instrumentation, measurements and analysis-B.S.Nakara, Chaudhari, TMH.
4. Instrumentation measurement - Moorthy, Prentice Hall of India.
5. Industrial Electronics, Circuits, Instruments and control techniques, - Terry Bartelt- Delmer - Cengage

Paper-III: POWER ELECTRONICS

Unit 1: Controlled Rectifier: (12)

a) Concept of uncontrolled and controller rectifiers.
b) Single phase circuits: Half & Fully controlled bridge rectifier with resistive R & R-L load with and without freewheeling diode, series & dual converter, power factor improvement.
c) Three phase circuits: Half controlled rectifier, Half controlled Bridge rectifier, Fully controlled Bridge rectifier with R & R-L load, three phase dual converter.

Unit 2: AC Voltage Controllers: (08)

a) Introduction to AC Voltage controllers AC On / Off control, Effect of duty cycle.
b) Concept of Phase control, Single Phase Uni-directional and bidirectional controllers with resistive & inductive loads.
c) Three phase half & full wave controllers with resistive & inductive loads.

Unit 3: Inverters: (08)

a) Operating principle. Single phase bridge inverter, steady state analysis. Mcmurray half and full bridge inverter, McMurray-Bedford half and full bridge inverter
b) Three phase inverter, PWM inverters, single phase PWM and Multiphase PWM inverters. Reduction of harmonics.
c) Current source inverters single phase current source inverters with R load.

Unit 4: Choppers: (12)

a) Operating principle, control strategies, time ratio control, step –up and step down chopper with R load, Class A, B, C, D, E Choppers
b) Multiphase choppers and AC choppers. .

Unit 5: Cycloconverter: (09)

a) Introduction to cycloconverter, types of cycloconverter.
b) Single Phase Cycloconverter, Mid point cycloconverter, Bridge type cycloconverter, step up cycloconverter.
c) Three phase cycloconverters. Three phase to single phase, three phase to three phase. Reduction of output harmonics.
d) Microcontroller based firing schemes.

Reference Books:

1. Power Electronics – M.H. Rashid, PHI.
2. Power Electronics –Singh – Kanchandani- TMH
3. Industrial and Power Electronics – Deodatta Shingare Electrotech publication,
4. Power Electronics – P. S. Bhimra Khanna publisher, New Delhi.

Paper IV: Advanced Microcontrollers

Unit – I PIC Microcontrollers 20

- **Introduction:** Advantages of PIC microcontrollers over MCS-51 series. PIC microcontroller features, Architecture of PIC microcontrollers, Pin Description, 16CXX series. Architecture of 16F877. Memory structure, Resisters, Register file structure, Register banks, program and data memory, Use of EEPROM, SFRs, W-register, Status register, Option register etc. Interrupts in PIC microcontrollers, IO ports of 16F877. Timers of PIC Microcontrollers, Compare capture mode, PWM mode, I2C bus , On Chip ADC and DAC facility. USART the serial IO, watchdog timer, Power up timer, Sleep mode, Reset, and clock circuits, types of the RESET. Interrupt vector table. Introduction of 18FXX series.
- **Instruction Set :** Instruction set, instruction format, byte oriented instruction, bit oriented instruction, literal instruction, flow control instruction. Addressing modes
- **Integrated Development Tools for PIC**: Overview of MPLAB the IDE for Assembly language. Micro C the IDE for embedded C programming. Developing, compiling, and programming the microcontroller, Some programs on IO port, timer and serial IO programming.

Unit – II AVR Microcontrollers 20

- **Introduction to AVR**: General architecture of AVR microcontroller family. Salient features, AVR Series .
- **Architecture:** Architecture and hardware resources of AVR ATMega 8L, The arithmetic logic unit, program memory & data memory, Downloadable Flash program memory, SRAM data memory, General- purpose register file, SFRs, I/O register, EEPROM data memory, IO port structure, Peripherals, timer and counters, watchdog timer, Serial Peripheral interface, universal asynchronous receiver and transmitter, Analog comparator, reset and interrupt, interrupt vector table, reset sources. On chip ADC and DAC , Reset circuit and clock circuit.
- **Instruction set:** Instruction set, Memory addressing modes, Register direct addressing, I/O direct addressing, SRAM direct addressing, SRAM indirect addressing constant addressing using the LPM instruction , Arithmetic instruction, Logical and bit wise instructions, Jumps and calls, instruction set, reset and interrupt handling, watchdog handling , stack, program constructs, conditional branches, program loops , refreshing port pins and important register, polling inputs.

1. **Integrated Development Tools for AVR**: Study of development tools of ATMEL AVR microcontrollers, ATMEL AVR Studio, WinAVR and Codevision

Unit – III Programming and interfacing with AVR & PIC 9

- **Interfacing with AVR and PIC mecrocontrollers:** Interfacing of IO devices to the ports. Memory interface I/O Interface Interfacing smart LCD, relay, opto-coupler, Interfacing ADC & DAC, firing of thyristor,.
- **Development of embedded system for**
    a. Temperature controlling
    b. Measurement of pH
    c. DC Motor controlling by using PWM techniques.

Reference Books:

1. PIC Microcontrollers and Embedded systems using Assembly and C for PIC18 – M.A. Mazidi, R. D. Mckinlay and D. Causey - Pearson Education, New Delhi- 2009.
2. Embedded design with PIC18F452, John B.Peatman
3. Embedded C programming and the Microchip PIC – Richard Barnet, L.O.Cull and S. Cox Delmer.-2004.
4. PIC Microcontroller: An Introduction to software and hardware interfacing, Han-Way Huang, Delmar
5. Microcontrollers Theory and Application – Ajay V. Deshmukh TMH New Delhi
6. Embedded C Programming and the Atmel AVR, Richard H. Banett, Sarah A. Cox, Larry D. O'Cull, Thomson.
7. AVR: An Introductory Course, John Morton, Newnes.
8. Programming and customizing The AVR Microcontroller, Dhananjay Gadre, TMH.

Paper –V: CONTROL THEORY

Unit 1: Fundamentals of Control Systems: (06)

Introduction The control system , basic definitions, close and open loop system, block diagrams, comparison of open and closed loop systems. Transfer functions and signal flow graphs

Unit 2: Feedback characteristics of control system: (08)

Feedback and Non feedback system, Reduction of parameter variation using feedback, Control of system dynamics, Control of the effects of disturbance signals using feedback, Regenerative feedback

Unit 3: Time domain analysis and Stability : (10)

Standard test signals, Time domain performance of control systems, Transient response of the first, the second and the higher order systems, Steady state errors, Effect of adding zero to the system, Design specification of second order system. Concept of poles and zeros

The concept of stability, Necessary conditions for stability Routh stability criterion.

Unit 4: Root locus techniques: . (08)

The Root locus concept, construction of root loci, Root contours, system transportation lag

Unit 5: Frequency domain analysis and stability: (10)

Correlation between time and frequency response, Polar plots, Bode plots, all pass and minimum phase system, experimental determination of transfer function, log magnitude verses phase plots, Nyquist stability criteria, Assessment of sensitivity analysis in frequency domain.

Unit 6: Control actions and industrial process control: (08)

Introduction, Process control system, Roll of controllers in process industry, Concept of sequencing and modulating controllers,

Control actions, Discontinuous (ON-OFF) and Continuous control modes, Proportional (P), Derivative (D) and Integral (I) controller, Composite (PI, PD, PID) controllers, their performance and characteristics.

Reference Books

1. Control system Engineering-J.J.Nagrath, M. Gopal, 2nd Edition, Wiley Eastern Ltd.
2. Modern control Engineering-K. Ogata, Prentice Hall of India.
3. Automatic control systems-B.C. Kuo, Prentice Hall of India.
4. Control system –Smarajit Ghosh, Pearson Education (Singapore). Ltd.

Paper- VI Real Time Operating System

Unit 1: Embedded system design with AVR microcontrollers: (14)

a) **Introduction:** Concept of embedded system, structure of embedded system, characteristics of embedded system, types of embedded system,

b) **Microcontroller based embedded system:** Minimum requirement. Microcontroller, Clock circuit, Reset circuit, In system programming (ISP)

c) **Embedded system design:** Designing of AVR A Tmega8L microcontroller based embedded systems for Measurement of pH, Humidity, wind velocity, temperature etc.

Unti 2: Fundamental of Real Time Operating System (10)

a) **Introduction:** Concept of Real Time, Real Time operating System, Characteristics of Real-Time operation system, Hard and Soft Real Time Systems.

b) **Structure of RTOS:** Structure of RTOS, RTOS Kernel, Kernel Objects, Services of Scheduler.

c) **Task:** Task structure, Creation of task, types of task, Task Control block, context, States of task and FSM, idle task, Priority, Static and dynamic priority, Resources, Sharing of resources, ISR, Task Management.

d) **Scheduling Algorithm:** Task scheduling Algorithm, preemption, FIFO, Round Robin scheduling, priority based preemptive scheduling. Priority Inversion, Software and hardware time Ticks, context switching.

e) Simple programs based on Tiny RTOS kernel.

Unit 3: Task Synchronization and Intertask communication: (8)

a) **Synchronization of task:** Concept of Sharing of resources, Race condition, Critical condition, deadlocks, spinlocks,

b) **Semaphores and mutexes:** Concept of semaphore, Binary semaphore, Counting semaphore, Semaphore management, **Mutexes:** Concept of mutex, mutex management.

c) **Intertask communication:** Intertask Communication, Messages, Queues, Mailboxes.

Unit 4: The RTOS Kernel MicroC/OS-II (5)

MicroC/OS-II kernel, creation of task, task management, Simple programs on creation of task.

Unit 5: **The RTOS RTLinux:** (8)

RTLinux Kernel, POSIX Pthreads, Processes and Threads, Thread Basics, Process management, semaphores, mutexes. Simple programs on creation of threads.

Reference Books:

1. Embedded C – Michael J Pont
2. Go Embedded – Yashawant Kanetkar BPB.
3. Embedded C Programming and the Atmel AVR – R. H. Barnett, S. Cox and L. O'Cull
4. Embedded C Programming and the Microchip PIC – R. H. Barnett, S. Cox and L. O'Cull
5. Operating Systems – A. S. Godbole
6. Real-Time Systems – C. M. Krishna and K.G. Shin
7. Embedded / Real Time Systems – Concepts design – programming – KVVK Prasad.
8. MicroC/OS-II, The Real Time Kernel, - J. J. Labrosse, 2nd Edn. (2006) CMP Books New york.

PAPER VII- OPTO ELECTRONICS

Unit 1. Optical fibers: **(6)**

Construction and working principle of optical fiber, Types of optical fiber, Numerical aperture, Pulse spread due to material dispersion, loss mechanism, modes in steps and grade index fiber.

Unit 2. Optical Sources: **(6)**

Optical sources, LED, He-Ne laser, working principle spectral and spatial characterization.

Unit 3. Optical detectors: **(10)**

Types of detectors, Thermal detectors, semiconductor detectors, Photodiodes, APD, PIN photodiodes, photo transistors, working principle and characteristics.

Unit 4. Modulation of light. **(14)**

Concept of Intensity Modulation, Birefringence, Quarter wave plate, linear Electro optic(EO) effect, working of pocket cell as modulator and deflector, Kerr modulators, Magneto optic devices, Faraday effect, Acoustic optic(AO) devices, AO working principles, AO modulator

Unit 5. Fiber Optics Technology **(8)**

Glass fiber fabrication, Introduction to cable design, coupling, splicing and connectors, splicing methods, types fiber measurements (NA, Loss measurement, connector & splice loss, dispersion)

Reference Books:

1. Optical Fiber Communication by A. Selvarajan and etal TMH, 2002.
2. Optical Fiber Communication by Gerd Keiser , MGH , 1998.
3. Optical Electronics, 4th Edition by A. Yariv, HRW publication, 1991.
4. OPTOELECTRONICS: An introduction By J.Wilson and J.F.B.Hawkes, PHI 1983

Paper – VIII: ELECTRONICS CIRCUIT DESIGN

Unit 1: **(10)**

Zener Series and shunt regulator, Transistorized series and shunt regulators, rectifier design with discrete component and ICs (741/78xx), current sources and their design with discrete components, and ICs SMPS design.

Unit 2: **(13)**

Design of multivibrator (Astable, Monostable, Bistable) using ICs (555,741),Schmitt trigger, triangular waveform generator, Design of oscillators(wein bridge, phase shift colpitts, Harteley) using 741,PLL IC LM 565,VCO LM 566, Analog multiplexer IC Cd 4051/52,Design of RF tuned amplifier.

Unit 3 : **(15)**

CMOS-TTL and CMOS-TTL interfaces, Design of counter using flip/flop and counter ICs, oscillator design using Schmitt trigger (7414), Inverter and NAND gate, Monostable multivibrator using gates and ICs (74/54121,74221), Design of binary to gray code converter, Design of BCD to excess 3 and excess 3 to BCD converter, Design of full adder using MUX, Design of 16 to 1 MUX using 4 to 1 MUX ,Design of parity checker, Memory interfacing: RAM ,ROM,EEPROM.

Unit 4: **(12)**

Design of ON –off proportional and PID controller, Design of capacitance and inductance meter, Design of DVM using 7107, Design of frequency synthesizer, Design of digital multimeter.

Reference Books :

1. Introduction to system Design using IC's- B.S. Sonde, Wiley Western Ltd.
2. Circuit Consultants Handbook – Hemmingway
3. Microprocessor and Micro-computer – B.P.B Handbook
4. Digital fundamentals – Flyod, UBS, New Delhi
5. Designing with op-amps and Analog and digital IC's S. Francio, MC Graw Hill.
6. Applications and Design with analog IC's, J. Michel Jacob, Prentice Hall of India.

List of Practicals for Semester –I

1. C Programming : Solution of system of linear equation by Gaussian Elimination method.
2. C Programming : Solution of system of linear equation by Gauss-Jordon Elimination method.
3. C Programming : Study of Least Squares Fitting method for curve fitting.
4. C Programming : Study of Newton Forward and Backward method for interpolation
5. C Programming : Simulation of RC differentiator and Integrator circuit.
6. Interfacing of Humidity Sensor
7. Interfacing of Temperature sensor
8. Study of programmable Instrumentation amplifier
9. Interfacing of IR based sensor
10. Interfacing Pressure sensor
11. Study of 4-20 mA current loop
12. Study of V-F /F-V converter
13. Determination of I_L & I_H of SCR.
14. Single phase Bridge Inverter
15. AC voltage controllers : On-Off with resistive load
16. AC voltage controllers : On-Off inductive load
17. Interfacing with AVR microcontroller : LED, Relay, Switch
18. Interfacing with AVR microcontroller : LCD
19. Interfacing with AVR microcontroller : Stepper motor
20. Interfacing with AVR microcontroller : Serial communication
21. Interfacing with PIC microcontroller : Study IO ports
22. Interfacing with PIC microcontroller : PWM /Servomotor
23. Interfacing with PIC microcontroller : I2C communication
24. Interfacing with PIC microcontroller : ADC

The practicals will be set as per availability of the laboratory, but at least up to 80% of the above mentioned. Experiments of Semester –I & II may be reshuffled.

List of Practicals for Semester –II

1. MATLAB : Study of Open loop and close loop system (DC Motor control)
2. MATLAB : Study of Proportional (P)control loop
3. MATLAB : Study of Proportional + Integral (PI)control loop
4. MATLAB : Frequency Domain Analysis
5. MATLAB : Study of Proportional + Integral + Derivatives (PID)control loop
6. RTOS : Creation of task
7. RTOS : Intertask communication
8. RTOS : Interfacing of IO devices in RTOS
9. RTOS : Study of semaphores and Mutexes
10. RTOS : Sharing of resources
11. Five Experiments on Electronic Circuit design
12. Communication :
13. Communication :
14. Communication :
15. Communication :
16. Communication :

The practicals will be set as per availability of the laboratory, but at least up to 80% of the above mentioned. Experiments of Semester –I & II may be reshuffled.