

**ANNA UNIVERSITY :: CHENNAI – 600 025**

**DEGREE OF BACHELOR OF ENGINEERING**

(8 SEMESTER PROGRAMME)

**B.E. BIOMEDICAL ENGINEERING**

**CURRICULUM 2001**

**SEMESTER V**

<b>Code No.</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>M</b>
<b>THEORY</b>					
GE035	<a href="#">Professional Ethics</a>	3	0	0	100
EC333	<a href="#">Digital Signal Processing</a>	3	1	0	100
BM331	<a href="#">Bio control systems</a>	3	1	0	100
BM332	<a href="#">Bio medical Instrumentation</a>	3	0	0	100
BM333	<a href="#">Bio materials and Artificial organs</a>	3	0	0	100
EC331	<a href="#">Microprocessor and application</a>	3	0	0	100
EC336	<a href="#">Computer Architecture</a>	3	0	0	100
<b>PRACTICAL</b>					
BM334	<a href="#">Microprocessor Lab</a>	0	0	3	100
BM335	<a href="#">Biomedical Instrumentation Lab</a>	0	0	3	100

**SEMESTER – VI**

<b>Code No.</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>M</b>
<b>THEORY</b>					
EC056	<a href="#">Digital Image Processing</a>	3	0	0	100
MG325	<a href="#">Engineering Economics and Financial Accounting</a>	3	0	0	100
BM341	<a href="#">Radiological Equipments</a>	3	0	1	100
BM342	<a href="#">Diagnostic and Therapeutic Equipments I</a>	3	0	1	100
IF353	<a href="#">Visual Programming</a>	3	0	0	100
E1***	Elective I	3	0	0	100
<b>PRACTICAL</b>					
BM343	<a href="#">Digital Signal Processing Lab</a>	0	0	3	100
IF358	<a href="#">Visual Programming Lab</a>	0	0	3	100

**SEMESTER – VII**

<b>Code No.</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>M</b>
<b>THEORY</b>					
BM431	<a href="#">Hospital Management</a>	3	0	0	100
BM432	<a href="#">Computers in medicine</a>	3	0	0	100
BM433	<a href="#">Medical Optics</a>	3	0	0	100
BM434	<a href="#">Diagnostic and therapeutic equipments II</a>	3	0	0	100
CE071	<a href="#">Principles of Environmental Science and Engg.</a>	3	0	0	100
E2***	Elective II	3	0	0	100
<b>PRACTICAL</b>					
BM435	Hospital Training	0	0	4	100
BM436	<a href="#">Diagnostic and therapeutic equipments lab</a>	0	0	3	100
BM437	Comprehension	0	0	3	

**SEMESTER – VIII**

<b>Code No.</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>M</b>
<b>THEORY</b>					
GE406	<a href="#">Total Quality Management</a>	3	0	0	100
E3***	Elective III	3	0	0	100
<b>PRACTICAL</b>					
BM444	Project	0	0	12	100

**1. DISCRETE – TIME SIGNALS AND SYSTEMS : 10**

Sampling of Analogue signals – aliasing – standard discrete time signals – classification – discrete time systems – Linear time invariant stable casual discrete time systems – classification methods – linear and circular convolution – difference equation representation – DFS, DTFT, DFT – FFT computations using DIT and DIF algorithms. Time response and frequency response analysis of discrete time systems to standard input signals.

**2. INFINITE IMPULSE RESPONSE DIGITAL FILTERS: 9**

Review of design of analogue Butterworth and Chebyshev Filters, Frequency transformation in analogue domain – Design of IIR digital filters using impulse invariance technique – Design of digital filters using bilinear transform – pre warping – Frequency transformation in digital domain – Realization using direct, cascade and parallel forms.

**3. FINITE IMPULSE RESPONSE DIGITAL FILTERS: 9**

Symmetric and Antisymmetric FIR filters – Linear phase FIR filters – Design using Frequency sampling technique – Window design using Hamming, Hanning and Blackmann Windows – Concept of optimum equiripple approximation – Realisation of FIR filters – Transversal, Linear phase and Polyphase realization structures.

**4. FINITE WORD LENGTH EFFECTS: 8**

Quantization noise – derivation for quantization noise power – Fixed point and binary floating point number representations – Comparison – Overflow error – truncation error – coefficient quantization error – limit cycle oscillations- signal scaling – analytical model of sample and hold operations.

**5. SPECIAL TOPICS IN DSP: 9**

Discrete Random Signals- Mean, Variance, Co-variance and PSD – Periodiogram Computation – Principle of Multi rate DSP – decimation and Interpolation by integer factors – Time and frequency domain descriptions – Single, Multi stage, polyphase structures – QMF filters – Subband Coding

**TOTAL : 60**

**TEXT BOOK:**

1. John G. Proakis and Dimitris G.Manolakis, 'Digital Signal Processing, Algorithms and Applications', PHI of India Ltd., New Delhi 3<sup>rd</sup> Edition 2000.

**REFERENCE:**

1. Sanjit K.Mitra 'Digital Signal Processing', A Computer Based Approach, Tata McGraw-Hill, New Delhi, 1998.



**1. BIO-POTENTIAL ELECTRODES****9**

Electrode electrolyte interface, half-cell potential, polarisation and non-polarisable electrode, calomel electrode, needle and wire electrode, microelectrode-metal micropipete.

**2. RECORDING SYSTEM****9**

Low-Noise preamplifier, main amplifier and driver amplifier, inkjet recorder, thermal array recorder, photographic recorder, magnetic tape recorder, X-Y recorder, medical oscilloscope.

**3. BIO-CHEMICAL MEASUREMENT****9**

pH, pO<sub>2</sub>, pCO<sub>2</sub>, pHCO<sub>3</sub>, Electrophoresis, colorimeter, spectro photometer, flame photometer, auto analyser.

**4. NON-ELECTRICAL PARAMETER MEASUREMENTS****9**

Respiration, heart rate, temperature, pulse blood pressure, cardiac output, O<sub>2</sub>, CO<sub>2</sub> measurements.

**5. BLOOD FLOW AND BLOOD CELL COUNTING****9**

Electromagnetic and ultrasonic blood flowmeter, indicator dilution method, thermodilution method, manual and automatic counting of RBC, WBC and platelets.

**TOTAL : 45****REFERENCES:**

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 1998.
2. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 1997.
3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 1997.
4. Joseph J.carr and John M. Brown, "introduction to Biomedical equipment technology", John wiley and sons, New York, 1997.

**1. STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY 9**

Definition and classification of bio-materials, mechanical properties, visco elasticity, wound-healing process, body response to implants, blood compatibility.

**2. IMPLANT MATERIALS 9**

Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite glass ceramics carbons, medical applications.

**3. POLYMERIC IMPLANT MATERIALS 9**

Polymerisation, polyolefin, polyamides , Acrylic, polymers, rubbers, high strength thermoplastics, medical applications.

**4. TISSUE REPLACEMENT IMPLANTS 9**

Soft-tissue replacements, sutures, surgical tapes, adhesive, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements.

**5. ARTIFICIAL ORGANS 9**

Artificial Heart, Prosthetic Cardiac Valves, Limb prosthesis, Externally Powered limb Prosthesis, Dental Implants

**TOTAL : 45****REFERENCES:**

1. PARK J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.

**1. 8-BIT MICROPROCESSOR:****9**

8085 Architecture and Memory interfacing, interfacing I/O devices, Instruction set, Addressing Modes, Assembly language programming, counters and time delays, interrupts, timing diagram, Microprocessor applications.

**2. MICROCONTROLLER:****9**

Intel 8031/8051 Architecture, Special Function Registers (SFR), I/O pins, ports and circuits, Instruction set, Addressing Modes, Assembly Language Programming, Timer and Counter Programming, Serial Communication, Connection to RS 232, Interrupts Programming, External Memory interfacing, Introduction to 16 bit Microcontroller

**3. 80X86 PROCESSORS:****9**

8086 Architecture, Pin Configuration, 8086 Minimum and Maximum mode configurations, Addressing modes, Basic Instructions, 8086 Interrupts, Assembly levels programming. Introduction to 80186, 80286, 80386, 80486 and Pentium processors.

**4. PERIPHERALS AND INTERFACING:****9**

Serial and parallel I/O (8251 and 8255), Programmable DMA Controller (8257), Programmable interrupt controller (8259), keyboard display controller (8279), ADC/DAC interfacing. Inter integrated circuits interfacing (I<sup>2</sup>C standard).

**5. MICROPROCESSOR BASED SYSTEMS DESIGN, DIGITAL INTERFACING:****9**

Interfacing to alpha numeric displays, interfacing to liquid crystal display (LCD 16 x 2 line), high power Devices and Optical motor shaft encoders, stepper motor interfacing, Analog interfacing and industrial control, microcomputer based smart scale, industrial process control system, Robotics and Embedded control, DSP and Digital Filters.

**TOTAL : 45****TEXT BOOKS:**

1. Ramesh S. Gaonkar, Microprocessor Architecture Programming and Applications with 8085. Fourth edition, Penram International Publishing 2000.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, The 8051 Microcontroller, and Embedded Systems, Prentice Hall 2000.
3. Douglas V.Hall, Microprocessor and Interfacing, Programming and Hardware. Tata McGraw-Hill, Second Edition. 1999.

**REFERENCES:**

1. Kenneth J.Ayala., "The 8051 Microcontroller Architecture Programming and Applications", Penram International Publishing (India). 1996.

2. Kenneth J.Ayala “The 8086 Microprocessor, Programming and Interfacing the PC”, Penram International Publishing. 1995.
3. Barry.B.Brey. “The Intel Microprocessor 8086/8088. 80186, 80286, 80386 and 80486 Architecture Programming and Interfacing”, Prentice Hall of India Pvt.Ltd.1995.
4. Ray A.K.Bhurchandi.K.M, “Advanced Microprocessor and Peripherals”, Tata McGraw-Hill, 2002.

**1. INTRODUCTION 9**

Computing and Computers, evolution of computers, VLSI era, system design- register level, processor level, CPU organization, Data representation, fixed – point numbers, floating point numbers, instruction formats, instruction types.

**2. DATA PATH DESIGN 9**

Fixed point arithmetic, addition, subtraction, multiplication and division, combinational and sequential ALUs, carry look ahead adder, Robertson algorithm, booth's algorithm, non-restoring division algorithm, floating point arithmetic, coprocessor, pipeline processing, pipeline design, modified booth's algorithm

**3. CONTROL DESIGN 9**

Hardwired Control, micro programmed control, Multiplier control unit, CPU control unit, Pipeline control, instruction pipelines, pipeline performance, super scaling processing, Nano programming.

**4. MEMORY ORGANIZATION 9**

Random access memories, serial access memories, RAM interfaces, magnetic surface recording, optical memories, multilevel memories, Cache & virtual memory, memory allocation, Associative memory.

**5. SYSTEM ORGANIZATION 9**

Communication methods, buses, bus control, bus interfacing, bus arbitration, IO and system control, IO interface circuits, DMA and interrupts, vectored interrupts, PCI interrupts, pipeline interrupts, IOP organization, operation systems, multiprocessors, fault tolerance.

**TOTAL : 45****TEXT BOOKS:**

1. Morris Mano, "Computer System Architecture", Prentice-Hall of India, 2000.
2. John P.Hayes, 'Computer architecture and organisation', Tata McGraw-Hill, Third edition, 1998

**REFERENCES:**

1. V.Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation", IV edition, McGraw-Hill Inc, 1996.
2. H.S. Stone, "High Performance computer architecture", Addison Wesley, Third Edition, 1993.
3. K.Hwang, "Advanced computer architecture", Tata McGraw-Hill, 1993.
4. J.Vaideeswaran, "Computer architecture", New Age International, 1999.

5. G.Kane & J.Heinrich, "MIPS RISC Architecture", Englewood cliffs, New Jersey, Prentice Hall, 1992.

**BM334**

**MICROPROCESSOR LAB**

**0 0 3 100**

1. Programming 8085.
2. Programming 8086.
3. Micro controller.
4. PC based systems.
5. Stepper motor control.
6. Display control.
7. A/D and D/A interfacing.
8. Mini Projects.

**BM335**

**BIOMEDICAL INSTRUMENTATION LAB**

**0 0 3 100**

1. Study of Biological Preamplifiers.
2. Recording of ECG signal and Analysis.
3. Recording of Audiogram.
4. Recording of EMG.
5. Recording of EEG.
6. Recording of various physiological parameters using patient monitoring system and telemetry units.
7. Measurement of pH, pO<sub>2</sub> and conductivity.
8. Study and analysis of functioning and safety aspects of surgical diathermy.
9. Mini project.





**REFERENCES:**

1. R.R.Barthwal, "Industrial Economics", Wiley Eastern Ltd.,
2. G.S.Gupta, "Managerial Economics", Tata McGraw-Hill Ltd.,
3. M.Y.Khan & P.K.Jain, " Basic Financial Management", Tata McGraw-Hill Ltd.,

<b>BM341</b>	<b>RADIOLOGICAL EQUIPMENTS</b>	<b>3 1 0 100</b>
<b>1.</b>	<b>X-RAYS</b>	<b>10</b>
	Principles and production of soft and hard X-rays, selection of anodes, Heel Pattern. Scattered radiation, Porter Bucky system, Cooling system.	
<b>2.</b>	<b>RADIO DIAGNOSIS:</b>	<b>9</b>
	Radiography, Angiography, Fluoroscopy, Image Intensifier, Multi section radiography.	
<b>3.</b>	<b>SPECIAL RADIOLOGICAL EQUIPMENTS</b>	<b>10</b>
	Principle, Plane of Movement, Multi section Radiography, CAT. Principle of NMR, MRI	
<b>4.</b>	<b>APPLICATION OF RADIOISOTOPES</b>	<b>10</b>
	Alpha, Beta and Gamma emission, Principle of radiation detectors, dot scanners, nuclear angiogram, Principles of Radiation therapy.	
<b>5.</b>	<b>RADIATION SAFETY</b>	<b>(6)</b>
	Hazardous effect of Radiation, Radiation protection Techniques, Safety Limits, Radiation Monitoring.	

**TOTAL : 45 + LAB 15**

**REFERENCES:**

1. R.S.Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1997.
2. Steve Webb, "The Physics of Medical Imaging ", Adam Hilger Philadelphia 1988.
3. William R.Hendee, E.Russel Ritenour," Medical Imaging Physics", Third Edition, Mosby Year Book, St. Louis, 1992.



**1.            INTRODUCTION TO WINDOWS PROGRAMMING                      8**

GUI Concepts – Overview of Windows programming – Creating the window - Displaying the window - message Loop – windows procedure-WM\_PAINT message - WM\_DESTROY message – An Introduction to GDI – Scroll Bars – Keyboard – Mouse – Menus.

**2.            VISUAL BASIC PROGRAMMING    9**

IDE – First Visual Basic Program - Introduction to Forms –Intrinsic Controls –working with Files - Accessing databases with data control - Classes and Objects – ADO Object Model.

**3.            VISUAL C++ PROGRAMMING    9**

Windows Programming Model - Visual C++ components – Microsoft foundation classes Library Application Framework – Getting Started with AppWizard – Basic Event handling, Mapping modes, and a Scrolling View - Graphics Device Interface, Colors and fonts – Modal Dialog and Windows Common Dialogs – Modeless Dialog and windows Common dialogs – Using ActiveX controls – Windows Message Processing and Multithreading.

**4.            ADVANCED CONCEPTS    9**

Menus – Keyboard Accelerators – Rich Edit Control – Tool bars – Status bars – A reusable Frame Window Base Class - Reading and writing documents - SDI and MDI environments – splitter windows and multiple views.

**5.            APPLICATIONS OF WINDOWS PROGRAMMING                                      10**

Dynamic link library – Component Object Model - Object linking and embedding – Data Base Management With Microsoft ODBC.

**TOTAL : 45**

**TEXT BOOKS**

1. Charles Petzold, “Windows Programming”, Microsoft press, 1996. Chapters: 2, 5, 6, 9, 10.
2. Francesco Balena, “Programming Microsoft Visual Basic6.0”, Microsoft press, Indian Reprint, 2001. Chapters: 1, 2, 3, 5, 6, 13.
3. David Kruglirski.J, “Programming Microsoft Visual C++”, Fifth Edition, Microsoft press, 1998. Chapters: 1,2,3,4,5,6,7,8,12,13,14,15,17,18,20,22,24,31.

**REFERENCES**

1. G.Cornell, “Visual Basic 6”, Tata McGraw-Hill, 1998.

2. Deitel & Deitel, T.R.Nieto, “Visual Basic 6, How to program”, Prentice Hall of India, 1999.

**BM343**

**DIGITAL SIGNAL PROCESSING LAB**

**0 0 3 100**

1. Representation of time-series; computation of convolution.
2. Response of a difference equation to initial conditions; stability.
3. DFT computation.
4. Computational experiments with digital filtering.
5. Sampling and waveform generation.
6. FIR and IIR filters implementation.
7. Fast Fourier Transform.
8. Quantization noise.
9. Adaptive filters.
10. Multirate signal processing.

**IF358**

**VISUAL PROGRAMMING LAB**

**0 0 3 100**

**1. VISUAL BASIC**

**15**

- i. Simple programs with control structures
- ii. Adding menus to forms
- iii. Creating dialog boxes with various options
- iv. MDI applications
- v. Writing code for various keyboard and mouse events
- vi. OLE container control
- vii. Simple programs with classes and objects
- viii. Data access through Data control and DAO.

**2. VISUAL C++**

**30**

- i. Creating applications with App wizard
- ii. Drawing in documents
- iii. Working with MFC
- iv. Creating simple SDI and MDI applications
- v. Exception handling
- vi. Loading - Editing and - Adding resources - Linking resources To applications
- vii. Drawing bitmaps
- viii. Threads
- ix. OLE
- x. Active X
- xi. DLL's

**TOTAL : 45**

**1. ENGINEERING ETHICS****9**

Senses of Engineering Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas. Moral Autonomy – Kohlberg’s theory – Gilligan’s theory – Consensus and Controversy – Professions and Professionalism – Professional ideals and virtues – Theories about right action – Self-interest – Customs and religion – Use of Ethical Theories.

**2. ENGINEERING AS SOCIAL EXPERIMENTATION****9**

Engineering as experimentation – Engineers as responsible experimenters – Codes of Ethics – A Balanced Outlook on Law – The Challenger Case Study.

**3. ENGINEER’S RESPONSIBILITY FOR SAFETY****9**

Safety and risk – Assessment of safety and risk – Risk Benefit Analysis – Reducing risk – The Three Mile Island and Chernobyl Case Studies

**4. RESPONSIBILITIES AND RIGHTS****9**

Collegiality and loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Discrimination.

**5. GLOBAL ISSUES****9**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Sample code of conduct.

**L = 45, TOTAL = 45****TEXT BOOKS**

1. Mike Martin and Roland Schinzinger, Ethics in Engineering, McGraw-Hill, New York, 1996
2. Charles D Fledderman, Engineering Ethics, Prentice Hall, New Mexico, 1999

**REFERENCES**

1. Laura Schlesinger, How Could You Do That: The Abdication of Character, Courage, and Conscience, Harper Collins, New York, 1996.
2. Stephen Carter, Integrity, Basic Books, New York 1996.
3. Tom Rusk, The Power of Ethical Persuasion: From Conflict to Partnership at Work and in Private Life, Viking, New York, 1993









- 1) Study of ultrasonic transducers and displays.
- 2) Study of pacemaker.
- 3) Multichannel biotelemetry.
- 4) Shortwave and ultrasonic diathermy.
- 5) Multichannel data acquisition system.
- 6) Simulation of biosignals.
- 7) Analysis of ECG signals.
- 8) Analysis of EEG signals.
- 9) Leakage current and electrical safety measurements.
- 10) Mini Project.

**1. INTRODUCTION 9**

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

**2. TQM PRINCIPLES 9**

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

**3. STATISTICAL PROCESS CONTROL (SPC) 9**

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

**4. TQM TOOLS 9**

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

**5. QUALITY SYSTEMS 9**

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

**TEXT BOOK:**

1. Dale H.Besterfield, et al., Total Quality Management, Pearson Education Asia, 1999. (Indian reprint 2002).

**REFERENCES:**

1. James R.Evans & William M.Lindsay, The Management and Control of Quality, (5<sup>th</sup> Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).
2. Feigenbaum.A.V. “Total Quality Management, McGraw-Hill, 1991.
3. Oakland.J.S. “Total Quality Management Butterworth – Heinemann Ltd., Oxford. 1989.

4. Narayana V. and Sreenivasan, N.S. Quality Management – Concepts and Tasks, New Age International 1996.
5. Zeiri. “Total Quality Management for Engineers Wood Head Publishers, 1991.

**CE071 PRINCIPLES OF ENVIRONMENTAL SCIENCE AND ENGINEERING 3 0 0 100**

**1. COMPONENTS OF ENVIRONMENT 9**

Components – Water, air and land – Inter-relationship between components – Subcomponents; Ecosystem – Structure and functional components of ecosystem – Development and evolution of ecosystem – Energy flow and material cycling in ecosystem – Natural and man made impacts on water, air and land; Environment and development – Concept of sustainable development.

**2. SCIENCE OF ENVIRONMENT 9**

Chemistry, Physics and biology of water, air and land; Stress on the Chemistry, Physics and Biology of water, air and land owing to the impacts; Environmental quality objective and goals – Policies on development projects and their impacts, with emphasis on the branch of engineering of the student.

**3. CURRENT ENVIRONMENTAL ISSUES 9**

Current Environmental issues at Country level – management of municipal sewage, municipal solid waste, Hazardous waste and Bio-medical waste – Air pollution due to industries and vehicles; Global issues – Biodiversity, Climatic change, Ozone layer depletion.

**4. ENGINEERING INTERVENTIONS TO REDUCE THE ENVIRONMENTAL STRESSES 9**

Minimisation of Stress – Principles of Physics, chemistry and biology in engineering interventions such as waste treatment – Flow sheets of engineering interventions relevant to the Engineering discipline of the student – Waste minimisation techniques – Clean technology options – Standards of performance of the interventions.

**5. (A) TOOLS FOR ENVIRONMENTAL MANAGEMENT 9**

Environmental impact assessment; Precautionary Principle and Polluter Pays Principle; Constitutional provisions, Legal and economic instruments in Environmental Management; Role of Non-government organisations – Community participation environmental management works; International conventions and protocols; Pollution Control Boards and Pollution Control Acts.

**(B) Field Study**

In-depth study of environmental issues at least one environmentally sensitive site relevant to the discipline of the student and preparation of a report thereupon.

**Total : 45**

**TEXT BOOKS:**

1. G.M.Masters, Introduction to Environmental Engineering & Science, Prentice Hall, New Delhi, 1997
2. J.G. Henry and G. W. Heike, Environmental Science & Engineering”, Prentice Hall International Inc., New Jersey, 1996.

**REFERENCES:**

1. S. K. Dhameja, Environmental Engineering and Management, S. K. Kataria and Sons, New Delhi, 1999.
2. State of India’s Environment – A Citizen’s Report, Centre for Science and Environment and Others, 1999
3. Shyam Divan and Armin Rosencranz, Environmental Law and Policy in India, Cases, Materials and Statutes, Oxford University Press, 2001.