STUDY AND EVALUATION SCHEME
FOR

M.E. INSTRUMENTATION AND CONTROL
(INDUSTRY-ORIENTED AND PRACTICE-BASED)
REGULAR AND MODULAR PROGRAMMES

OFFERED BY

NATIONAL INSTITUTE OF TECHNICAL TEACHERS’ TRAINING
& RESEARCH, CHANDIGARH

AFFILIATED TO PANJAB UNIVERSITY, CHANDIGARH

DEPARTMENT OF ELECTRICAL ENGINEERING,
NATIONAL INSTITUTE OF TECHNICAL TEACHERS’ TRAINING
& RESEARCH, SECTOR-26,
CHANDIGARH – 160 019

2011-2012
SCHEME FOR MASTER OF ENGINEERING (INDUSTRY ORIENTED AND PRACTICE BASED) PROGRAMME REGULAR AND MODULAR IN INSTRUMENTATION AND CONTROL

AIM

To offer Master of Engineering (industry oriented and practice based) Regular & Modular Programmes in Instrumentation and Control, for technical teachers and professionals working in industries.

RATIONALE

The rapid pace at which changes and advancements are taking place in technology pose a great challenge to training and supplying the right kind and quality of technical manpower. The training of technical personnel is largely influenced by the nature of curriculum, quality of instructional processes, management of instructional system and the role played by industry in their training.

In order to increase the relevance of technical personnel to the world of work, it has all along been felt that the nature of programmes offered by the technical institutes should be oriented towards technology applications and practices. These programmes should focus on learning of industrial practices, practical and generic skills of problem solving, learning to learn skill and entrepreneurship skill.

As per the latest recommendations of the AICTE regarding pay scales and qualifications for technical teachers, the minimum qualification for lecturers is prescribed as degree in Engineering or Technology or equivalent and they have to acquire Master’s degree or such higher qualifications for promotions to higher grades. Majority of these teachers are fresh graduates and lack the knowledge of industrial practices and related practical skills, which in turn affects, the quality of technician engineers produced by the Polytechnics/Engineering Colleges. They, therefore, need a strong orientation in technological and field practices in the areas of fabrication, erection, construction, installation, operation, production, testing, maintenance and quality control.

The practice-based M.E. degree programme in Instrumentation and Control will provide the above education and training to the Polytechnic/Engineering College teachers specially to equip them with the necessary knowledge and skills related to industry and field practices. They will be in a position to transfer such knowledge and training to the students of Polytechnics, so that their effective contribution in the world of work is increased.

In order to meet the above long felt need for higher education of polytechnic/Engineering College teachers, it is necessary to offer practice based Masters degree programmes specially designed to incorporate credit based system of evaluation. The system will have all the inbuilt flexibility to allow for self pacing, taking up study of
courses in the sequence and at the time convenient to in-service graduate personnel and obtaining specialization in the areas specific to their profession and carrier development.

In view of the above, NITTTR (earlier known as TTTI) Chandigarh have started offering a practice based M.E programme (Regular) in Instrumentation and Control for technical teachers having a B.E. degree or an A.M.I.E qualification in Electrical/ Electronics/ Instrumentation & Control Engineering or equivalent, since August, 1998. The course aims to provide an in-depth knowledge of field practices and ability to innovate and conduct research in technology areas. This will not only change the orientation of technician programmes but will also reduce the widening gap between technician courses and field practices and will greatly improve the performance of industries. Limited numbers of seats are also available to professionals working in industries and field organizations.

An acute problem faced by technical institutions both for degree and diploma level is that they are not able to spare their teachers for two long years for higher studies away from their institutes. In order to face the above situation, the institute is also offering another M.E. programme (Modular) in Instrumentation & Control for technical teachers and professionals working in Industries. This programme has been structured modular in nature where the teachers could be relieved from their institute to this institute for attending classes during summer and winter vacations. They will however also have to undertake follow up study when they return to their institutions so as to prepare themselves for University examinations before the beginning of subsequent modules. The contact type ME programme which is of two years duration has been made modular without any dilution with respect to rigour of teaching learning practices as also University examinations. However, the duration of the programme has been increased to 3 years. Classes will begin from first week of June and second week of December having a contact period of 5 weeks each where the students will study two subjects simultaneously.

Objectives
The specific objective of this course is Continuing Education and Training and Retraining of:

- in service technical teachers.
- industry personnel
- any other sponsored candidate desirous of pursuing a career in teaching.

Target Population
The envisaged target group includes:

- teachers with a B.E. degree or an equivalent qualification such as A.M.I.E. etc. in Electrical/Electronics/Instrumentation and Control Engineering.
- working professionals from Industries and other organizations having a B.E. degree in Electrical/Electronics/Instrumentation and Control Engineering or an equivalent qualification such as A.M.I.E. etc. in Electrical/ Electronics/ Instrumentation and Control Engineering.
SPECIAL FEATURES OF THE PROGRAMMES

i) Both the programmes are flexible, and allow self-pacing and taking up course of study in the sequence and at times convenient to the students:

ii) The courses focus on the mastery of minimum essential competencies and development of capabilities such as learning to learn, problem solving, human relations and management skills in addition to learning of Instrumentation Control Engineering subjects.

iii) These make use of a combination of instructional techniques such as group discussions, home assignments, individual and group projects, independent study, seminars etc.

iv) Assessment of student’s performance will be based on both continuous evaluation using variety of assessment techniques matching the learning objectives of the different courses of study and end of term University evaluation.

v) Completion of the course work is followed by Thesis work
The instructions for the paper setters for all the subjects of M.E. (Instrumentation & Control) are as follows:

1. The paper must be set by taking into consideration the total syllabus.
2. There should be in all 8 questions covering the total syllabus.
3. The examinees are supposed to attempt any five out of the 8 questions.
4. The paper should be set by following the principle of simple to complex approach.
5. The paper must be set in such a pattern that it examines knowledge, analytical power and the reasoning power of the examinee.
6. Wherever appropriate, proper numerical problems should be included.
7. Maximum marks for the paper should be 100 and time allotted should be three hours.
## STUDY & EVALUATION SCHEME
### OF M.E. IN INSTRUMENTATION & CONTROL – REGULAR PROGRAMME

#### Semester – I
#### Semester – II

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**NOTE:**

1. Requirement for the award of ME in Instrumentation & Control degree is 75 credits with minimum CGPA of 6.0 and successful completion of thesis work.

2. No numerical marks are to be assigned to thesis work. It is either “Accepted” or “Rejected”. Quality of work reported in thesis can be graded in term of “Very Good”, “Good” or “Average”.
# Study & Evaluation Scheme

## Of M.E. in Instrumentation & Control – Modular Programme

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<thead>
<tr>
<th>S. No.</th>
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## Scheme of Teaching

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## Marks

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| SPELL - II | 100 | 50 | 150 |

| SPELL - III | 100 | 50 | 150 |

| SPELL - IV | 100 | 50 | 150 |

| SPELL - V | 100 | 50 | 150 |

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DETAILED SYLLABUS FOR SUBJECTS

MIC 6101 MEASUREMENT SCIENCES

CONTENTS

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Introduction

Generalized Performance Characteristics

Static and Dynamic performance characteristics, Characteristic of periodic and transient inputs and the response of measuring system to these inputs. Response of measuring system to random inputs, Frequency spectra, auto correlation, cross correlation spectral density, Experimental determination of system parameters, requirement of instrument transfer function to ensure accurate measurement.

Measurement System

Classification of various types of transducers, fiber optic sensors, AC/DC signal conditioning, Analog to Digital and Digital to Analog converters, modulation – types, filters – active, passive, digital, Data transmission and telemetry-classification, Recorders – Types of recorders, XY-Plotters, Ultraviolet, magnetic and digital recording.

LABORATORY/FIELD EXPERIENCES

1. Experimental determination of system parameters.
2. Study and verification of transducer characteristics.
3. Study of signal conditioning techniques.
4. Verification of dynamic performance characteristics of a given system.
5. Case study of a real life measuring system in an industry.
6. Various data acquisition software.

BOOKS RECOMMENDED

3. Principles of Measurement and Instrumentation, Alan S Morris, Prentice Hall of India
4. Tranducers and Instrumentation, DVS Murthy, Prentice Hall of India
MIC 6102 PROCESS DYNAMICS AND CONTROL

CONTENTS

Review of Process and Control systems

Design aspects of Process Control System

Dynamic Behaviour of Feedback Controlled Process

LABORATORY/FIELD EXPERIENCES

1. Study and analysis of a feedback controller
2. Simulation of control schemes
3. Verification of desired characteristics of P,I,D, and PID controllers
4. Design fabrication and testing of an electronic controller
5. Case study of digital computer controlled system in industry
BOOKS RECOMMENDED

1. Techniques of Process Control P.S. Buckley, John Wiley and Sons, NY.
3. Principles of Measurement and Instrumentation, Alan S Morris, Prentice Hall of India
4. Tranducers and Instrumentation, DVS Murthy, Prentice Hall of India
5. Digital computer process control, C.L. Smith, Intext Educational Publishers, Scranton, P.A.
6. Chemical Process Control, George Stephonopoulos, Prentice Hall of India
CONTENTS

Introduction

Control system terminology, control theory history and trends, computer-based control. An overview of classical approach to analog controller design. Basic digital control scheme.

Signal processing in digital control


Models of Digital Control Devices and Systems

Z-domain description of sampled continuous-time plants and systems with dead-time, Digital Controller design using direct synthesis procedures.

Control System Analysis using State Variable Methods for Digital Control Systems

State variable representation, Conversion of state variable models to transfer function and of transfer function to canonical state variable models, Eigen values and Eigen vectors, Solution of state difference equations, controllability and Observability, Multivariable system.

Pole-Placement Design and State Observers


Lyapunov stability analysis

Basic concepts, Stability definitions and theorems, Lyapunov functions for linear and non linear systems, A model reference adaptive system.

Linear Quadratic Optimal Control

Parameter optimization and optimal control, Quadratic performance index, control configurations, State regulator design through the Lyapunov equation, Optimal state regulator through the Matrix Riccati-equation for digital control systems.
TUTORIALS

Various simulation exercises on different digital control using MATLAB.

BOOKS RECOMMENDED

1. Digital Control Systems; B.C. Kuo, Prentice Hall of India.
3. Digital Control & State Variable Methods; M Gopal TMH.
CONTENTS

PC as a platform for Data Acquisition
Origin of PC, Software-Operating systems, programming languages, hardware components – Mother Board – Microprocessors, Chipsets and support circuits, functions, system control, peripheral control, memory control BIOS and its functions.

Buses and Communications
History, Architecture, Bus function, Various buses; ISA,PCI,PCI-X, PCI-Express, PCMCIA, Infiniband, Hyper Transport.

Memory and Mass Storage Devices

Data Transfer – I/O devices

Interfacing
Local Area Networking - Concepts, Topologies, Standards, Hardware, Telecommunication-Analog and Digital Services, Internet–Addressing, Domain Name Systems, Routing. Design of DAS around PC, different DAQ cards and software. Interfacing of Add-on DAQ cards with PC using various buses.

LABORATORY/FIELD EXPERIENCES
1. Interfacing for measurement of standard physical parameters
2. Experimental set up for LAN in a laboratory
3. Designing and implementation of a real life PC based interfacing system.

BOOKS RECOMMENDED
1. Hardware Bible – Winn. L. Rosch, Techmedia, New Delhi
2. The Complete PC maintenance and upgrade guide – Mark Minasi, BPB publications.
3. 8086/8088 Programming – John Uffenbeck, PHI.
4. Structured Computer Organisation – Tanenbaum, PHI.
MIC 6105 INDUSTRIAL INSTRUMENTATION

CONTENTS

Measurement of Industrial parameters
Review of measurement and instrumentation system, Measurement of industrial parameters like: pressure, flow, level, temperature, displacement, velocity, acceleration, torque, Shaft power, humidity, moisture, viscosity, pH value measurement, sound level measurement.

Industrial data management and control
PLCs, Field bus concept, Data acquisition system, Data loggers, Supervisory control, DDC, DCS, SCADA, Instrumentation in hazardous situations, Robotics.

Unit Operation Monitoring
Instrumentation for optimization of unit operation e.g. heat exchanger, compressors, burners, weighing and batching, boilers, chillers, clean room, condenser, cooling towers, vapouriser, air handler etc.

Instrumentation in field
Study of instrumentation schemes for Thermal, Nuclear and Hydro power stations, Cement plant, Fertilizer, Chemical and Steel plant Paper industry etc.

LABORATORY/FIELD EXPERIENCES
1. Study of Instrumentation scheme at Thermal, Hydro, Nuclear Power station.
2. Study of instrumentation scheme at process industries e.g. cement, fertilizer, chemical, steel plant etc.
4. Case study of a PLC based instrumentation scheme in a process industry.
5. Experiments on PLC based instrumentation.

BOOKS RECOMMENDED
2. Structural synthesis of high accuracy automatic control systems; Meerov M.V. Pargaman Press, London.
3. Principles of Industrial Instrumentation; D. Patranabis, T.M.H.
MIC 6201 MICRO CONTROLLERS AND THEIR INTERFACING

CONTENTS

Overview of microprocessors

Microprocessor- Introduction, Basic architecture, differences between microprocessors and microcontrollers.

Micro Controllers

AT 89C2051 20 pin Microcontroller- Introduction, Architecture
8051 Microcontroller- Architecture, Memory Organization, Timer/Counters, Serial Ports, Parallel ports, Assembly language programming: Addressing Modes, Instruction set, Assemblers and Compilers, 8051 timer programming, Serial port programming.
Real world interfacing of 8051 with: LCD, keyboard, ADC and DAC .
Introduction to Advanced Microcontrollers: PIC, ARM and AVR- Introduction.

Embedded systems
An introduction to embedded systems, Classification of embedded systems.

LABORATORY/FIELD EXPERIENCES
1. Performing experiments on microcontroller universal kits
2. Programming Practices on 8051
3. Design of small embedded system projects

BOOKS RECOMMENDED
4. 8051 Microcontroller- I. Scott Mackenzie
6. Embedded Systems Design with 8051 Microcontrollers- Zdravko Karakehayov
7. The 8051 Microcontroller and Embedded systems-M.A.Mazidi, Pearson Education
CONTENTS

Air pollution measurement
Impact of man on the environment: An overview, Air pollution sources and effects, Meteorological aspects of air pollution dispersion. Air pollution methods and equipment, Air sampling techniques, gas analyzers, gas chromatography. Control of specific gaseous pollutants, measurement of automobile pollution; smoke level meter, orsat gas apparatus, CO/HC analyzer.

Water pollution measurement
Sources and classification of water pollutants; Biological oxygen demand (BOD), Chemical oxygen demand (COD), Dissolved oxygen (DO), waste water sampling and analysis, Waste water sampling techniques and analyzers, gravimetric, volumetric, calorimetric, potentiometer, flame photometry, atomic absorption spectroscopy, ion chromatography. Instruments used in wastewater treatment and control, solid waste management techniques.

Measurement of other pollutants
Measurement of radioactive pollutants, ganger counter, Noise level measurement techniques.

LABORATORY / FIELD EXPERIENCES
1. Experimental analysis of air pollution of a given sample
2. Study of air pollution control techniques used in a given industry
3. Sampling and analysis of pollution level of a given water sample
4. Case study of air pollution control in an industry
5. Case study of flue gas handling in a thermal power station
6. Case study of water pollution control.

BOOKS RECOMMENDED
1. Environmental Pollution Control Engineering; C.S. Rao; Wiley Eastern LTD, New Delhi.
2. Environmental Engineering, G.N. Pandy, G.C. Carney, TMH, New Delhi
CONTENTS

Analytical Methods of Measurements
Physical methods of chemical analysis, special methods of analysis, basic techniques, terminologies, units, Interaction of electromagnetic radiations with matter, emission, absorption and scattering techniques. Instrumentation related to X-Ray, Ultraviolet and Infrared techniques.

Special Analysis
Various light sources, spectrometer, detectors and data processing, comparison of various spectral analytical techniques, refractometry, nuclear magnetic resonance spectrometry. Analytical techniques based on separation method: Basics of chromatography liquid, gas and HPLC Mass Spectrometry and related instrumentation.

Electrometric Methods of Analysis

LABORAOTRY / FIELD EXPERIENCES
1. Study of operation and maintenance of mass-spectrometry related instruments
2. Study of operation and maintenance of pH and selective potentiometry related instruments.
3. Study of operation and maintenance of voltmetery related instruments
4. Study of operation and maintenance of colometery related instruments
5. Study of operation and maintenance of conductometery
6. Case study of operation and maintenance of an analytical instrumentation laboratory.

BOOKS RECOMMENDED
1. Instrumental Methods of Chemical analysis; Galen W. Ewing, McGraw-Hill, Koga Kusha Ltd.
4. Analytical Instrumentation HandBook: Galen W.Ewing, Marcel Decker Inc, USA.
MIC 6204  POWER PLANT INSTRUMENTATION

CONTENTS

Control of Power plants
Instrumentation scheme for monitoring and control of various parameters of power plants through control panels. Instrumentation scheme for operation and maintenance of generating units.

Load Despatch
Automatic load dispatch using computers. Software used for optimum generator allocation. Computer based data acquisition system for power plant operations, maintenance and protection. SCADA in power systems.

Instrumentation for Transmission
Instrumentation schemes used for HVDC & EHVAC transmission systems. Energy management: Electronic instrumentation schemes adopted for energy conservation and energy audit.

LABORATORY/ FIELD EXPERIENCES

1. Preparation of layout of instrumentation and control schemes in a power plant
2. Study of computerized load dispatch system
3. Study of instrumentation scheme for HVDC & EHVAC transmission systems.
4. Study of computer control scheme for data acquisition and supervisory control of a power plant.
5. Case study of an energy audit in a small/medium industry.

BOOK RECOMMENDED

3. Power system stability and control: Anderson and Fouad, Galgotia publications, New Delhi
4. Economic scheduling; S. Mukhopadhyay, Wiley Eastern
CONTENTS

Power Semiconductor diodes and transistors
Characteristics of power diodes, power transistor, power MOSFETS, insulated Gate Bipolar Transistor (IGBT), Mos-controlled thyristor and their comparison.

Thyristors and their characteristics
Review of thyristors such as SCR, TRIAC, GTO, PUT, SUS, SCS, ASCR, RCT. Thyristor Controlled Circuits.

Three phase controlled rectifiers
Single phase half wave and full wave converters, Analysis of three phase rectifier, Effect of source impedance on the performance of converters, Dual Converters.

Choppers
Control strategies, step up choppers, A, B, C, D and E type of choppers, Voltage, Current and Load commutated choppers.

Inverters
Single phase series and parallel inverter, single-phase & three-phase bridge inverters, Pulse width modulated inverters, Reduction of harmonics in the inverter output voltages, Current source inverter.

Cycloconverters
Single phase, Mid-point and bridge type cycloconverters. Three phase half-wave cycloconverters, Output voltage equation, Load commutated cycloconverters.

Electric drives
Single-phase and three-phase dc drives, chopper drives, ac drives, Induction motor drives, Speed control of three-phase induction motors, Synchronous motor drives, Microprocessor controlled ac and dc drives.

FACTS Controllers
SVC, TCSC, STATCOM, SSSC, UPFC

LABORAOTRY / FIELD EXPERIENCES
1. Basic experiments on thyristor and their applications.
2. Solid state control of drives.
3. Fabrication, testing and trouble shooting of various industrial electronic circuits.
4. Design and testing of thyristor based controllers for electric drives
5. Design and testing of microprocessor based drive controllers.
6. Study of applications of solid state control of industrial drives.
BOOKS RECOMMENDED

CONTENTS

Introduction  
Optical Electronics, Optical process in semiconductors.

Photo Sensitive Devices  
Light emitting diodes, Photo-diodes, Photoconductors, Junction photodiodes, PIN diodes, Avalanche photodiodes, Photo transistors, Optical sensors.

Lasers  

Optical fibre  
Introduction to fiber communication, Optical fiber materials, their properties, Optical fiber communication schemes, Comparison of optical fiber communication with the conventional communication.

LABORATORY / FIELD EXPERIENCES

1. Study and verification of characteristics of a light emitting diode.
2. Experiments on laser beam production and their control
3. Study and verification of Characteristics of a photo conductor device.
4. Study and verification of characteristics of an avalanche photo diode.
5. Study of an opto-electronic integrating circuit used in industries.

BOOKS RECOMMENDED

MIC 6207 DATA COMMUNICATION AND COMPUTER NETWORKS

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3 - 2

CONTENTS

Introduction
Uses of computer networks, Network hardware and software, Reference models, Example network, Example data communication services.

Physical Layer
Theoretical basis of data communication, Transmission media, Wireless transmission, Telephone system, Narrow band and Broadband ISDN and ATM, Communication satellites.

Data Link Layer
Design issues, error detection and correction, elementary data link protocols, sliding window protocols, protocol specification and verification, data link protocols.

Medium Access Sublayer
Channel allocation problem, Multiple access protocols, IEEE standard 802 for LANs and MANs, Design of LAN, Detection and management of collisions, Budes, High Speed LANs, Satellite networks.

Network Layer
Design issues, Routing algorithms, Congestion control algorithms, Internetworking, Network layer in the internet and in ATM networks.

Transport Layer
Transport service, Elements of transport protocols, Internet transport protocols, ATM AAC layer protocols, performance issues.

Application Layer
Network security, Domain name system (DNS), Simple network management protocol, Electronic Mail, Usenet, World wide web, Multimedia.

LABORATORY / FIELD EXPERIENCES

1. Testing x 2.5 and TCP/IP protocols.
2. Setting up LAN connection
3. Installing a bridge between networks.
4. Setting up a link through Async/Sync modems

BOOKS RECOMMENDED

1. Computer Networks – A. Tanenbaum – PHI
2. Data communication, networks and Systems – Thomas C. Bartee, Howard W. Sams & Co
5. Design & Analysis of Computer Communication Networks – Ahuja. V.
CONTENTS

Introduction
Classification of signals, concept of frequency in continuous-time and discrete-time signals, sampling theorem, Discrete-time signals and systems. Analysis of Discrete-Time Linear-time-invariant systems-convolution sum. Solution of linear constant coefficient difference equations, correlation of discrete-time signals

Z Transform
Review of direct and inverse z-transforms, solution of linear differential equations, Analysis of linear time-invariant system in the z-domain

Discrete Fourier Transform
Review of Fourier Series and Fourier transform of continuous time and discrete-time signals, DFT and its properties, Fast Fourier Transforms, various algorithms.

Structures for the Realization of Discrete-time System
Structures for FIR systems-Direct from I and II, cascade and parallel form, structures for IIR systems.

Design of Digital Filters

DSP Chips and their Application
TMS C3X series: Architectural overview, CPU, Memory types of Addressing, Applications.

LABORATORY / FIELD EXPERIENCES
2. Implementation of various filters
3. Use of DSP chips

BOOKS RECOMMENDED
1. Discrete-time signal processing, : A.V. Oppenheim and RW Schieffer, PHI.
2. Theory and applications of Digital Signal Processing, Rabiner and Gold, PHI
ARTIFICIAL NEURAL NETWORKS

Biological Neural Network—structure of human brain, Characteristics of ANN, Artificial neurons, Types of ANN—single layer and multilayer, Hopkinsons, counter propagation, back propagation, feedforward etc., Non Linear activation functions, Training of ANN and different training algorithms, bidirectional associative memories, various applications of ANN in the field of engineering in general and electrical engineering in particular, programming methods using ANN Techniques.

FUZZY LOGIC


LABORATORY / FIELD EXPERIENCES

1. Simulation of ANN for digit recognition
2. Application of fuzzy logic for language translation
3. Programming exercises in ANN, FL & GA using MATLAB and its tool boxes.

BOOKS RECOMMENDED

1. Neural Networks & Fuzzy systems: Kosko.B., Prentice Hall of India
5. Introduction to Artificial Intelligence and Expert Systems, D.W. Patterson, Prentice Hall of India
CONTENTS

1. Practices on Daisy Lab Software

2. Data Acquisition Practices with the help of various transducers & backup software.

3. Various practices using MATLAB/SIMULINK toolboxes

4. Minor Projects based on Application of Transducers

5. SCADA Software Applications.
CONTENTS

Introduction to Virtual Instrumentation: Historical perspective, advantages, block diagram and architecture of a virtual instrument, conventional vs virtual instrumentation.

Learning LabVIEW: Introduction to LabVIEW, Front panel, Block diagram, Menus, Palettes, VI and Sub VI, Editing and Debugging VI, Structures, Arrays, Clusters, Charts and Graphs, Data acquisition, Instrument Control, Signal Generation and Signal Processing Examples

Active Interaction Devices: Gloves, Data glove, Power glove, Dexterous hard master, Mice and joysticks, Wands, Force balls, Biological input sensors, Voice recognition, Data suit

Displays: Sequential Scan Converter for VR displays, Interlace/Non-interlace modes, Parallel-in/Serial-out mode; Serial-in/Parallel-out mode. Multi-display Systems, Helmet-mounted displays, monochrome CRTs with shutters.

Application of Virtual Instrumentation in various fields: Aviation, Automotive, High voltage, Defence, Chemical, Industrial, Marine, Medical, Mining, Nuclear Energy, Virtual landscapes.

LABORATORY / FIELD EXPERIENCES

1. Geographical programming using LabVIEW
2. Applications of LabVIEW

BOOKS RECOMMENDED

1. Learning with LabVIEW 7 Express – R.H. Bishop, Pearson Education, Delhi.
2. LabVIEW Basic 1 Course Manual, National Instruments
3. www.natinst.com
4. www.ni.com
CONTENTS

Data Communication
General communication system, ASK, FSK, PSK, DPSK, Modulation and demodulation techniques, Baseband signal receiver, Probability of error, Optimum filter, Matched filter correlator examples.

Pulse Modulation
Sampling, Nyquist theorem, Calculation of percentage distortion due to undersampling, Spectrum of sampled signal, sampling with narrow pulses, Pulse amplitude modulation, pulse width modulation, pulse position modulation, digital modulation principles, Pulse code modulation, intersymbol interference, eye patterns, equalization, companding, Bandwidth and noise of PCM systems, Delta modulation, Adaptive DM, Comparison between various techniques.

Information and Theory
Information, Entropy, Mutual information, Redundancy and channel capacity, Shannon – Hartley theorem, Bandwidth S/N Trade off

Coding Theory
Shannon’s Theorem, Coding of $\eta$, Shannon-fano coding, Huffman coding, Hamming coding, bit error detection and correction, Error detection using parity bits, Block codes, CRC, convolution codes, Line and interface coding, NRZ codes, Manchester codes, Miller code.

Modern Equipment
Modern Technology, Modem classification, Modem Modulation Methods, Modem Interface specifications, Modem Transmission characteristics, Modem features, compatibility, selection criteria.

Applications of Digital Communication
E-mail, voice managing, teletext, View Data, Digital satellite communication, Mobile Modulation System.

LABORATORY / FIELD EXPERIENCES
1. Implementation of ASK.
2. Practice on A/D cards.
3. Implementation of PCM
4. Familiarization and Application of modems.
BOOKS RECOMMENDED

2. Analogue and Digital Communication Techniques, Grahame Smilie, & Arnold, A Member of the Hoddes Headline Corporation, London
MTE 7103  TECHNOLOGY MANAGEMENT

CONTENTS

**Introduction of Technology Management**

**Technology Forecasting:**  Techniques of Forecasting, Technology Forecasting – Relevance Strategic alliance and Practicality, Technology transfer.

**Management of Research, Development and Innovation:**  Technology mapping, Comparison of types of R & D projects and development approaches – radical platform and incremental projects, innovation process.

**Management of Intellectual Property:**  Rights Strategic value of patents, trade secrets and licensing.

**Managing Scientist and Technologists:**  Identification, Recruitment, Retention, Team work and Result orientation.

**Management Roles and Skills for New Technology:**  Technology for Managerial Productivity and Effectiveness, Just-in-Time.

**Investment in Technology:**  Venture Capital & Technology Development.

**LABORATORY / FIELD EXPERIENCES**

- Technology forecasting and Technology mapping
- Technology Strategy Development
- Exercise on Just-in-Time
- Cases on Venture Capital

**BOOKS RECOMMENDED**
1. Technology and Management, Cassell Educational Ltd. London
5. Innovation and Entrepreneurship in Organizations, Richard M. Burton & Borge, Obel Elsevier
7. New Product management, C Marle Crawford, IR WIN, USA
CONTENTS

Introduction
Energy scenario-in context of Indian and global, conventional and non-conventional sources of energy, Renewable versus non-renewable sources of energy, Generation of electrical energy using non-conventional sources- Solar, Wind, Magnetohydro, Tidal, Geo-thermal, Ocean etc.

Energy Conservation
Various methods of energy conservation, Energy management techniques, case studies

Energy Efficient Technology
Technology for efficient utilization of electrical energy, Energy efficient devices, Instrumentation schemes for measuring and controlling electrical energy for implementation of energy efficient systems.

Energy Audit
Methods for doing preliminary, secondary and final energy audit, impact of power factor on electrical power systems, Improvement of power factor.

LABORATORY / FIELD EXPERENCES
Various Case Studies, Mini projects on energy audit.

BOOKS RECOMMENDED
Relevant journals and Reports
CONTENTS

Sensors and Transducers for biological applications
Types, properties, characteristics and selection of transducers for biological instrumentation.

Measurement of electrical parameters
Leads and electrodes, electrocardiography, electrical activity of the heart, equivalent cardiac generator. Einthoven lead system, standardization of recording and display of ECT (Electrocardiogram), EEG (Electroencephalogram), EMG (Electromyogram), EOG (Electroocculogram), ERG (Electroretinogram), EGG (Electrogastogram).

Measurement of non-electrical parameters
Bloodflow, droprecorder, electromagnetic flow meter, measurement of systolic and distolic pressures, blood pressure instruments, intraocular pressure, lung air pressure, audiometers. Measurement of body temperature, thermography. Cardiac tachometer, respiration rate phonocardiogram, heart sounds electrical stethoscope pulmonary function analysers. CO$_2$ - O$_2$ - Concentration in exhaled air, blood and lungs, pH value of blood, impedance pletnysmography blood gas analysers, blood cell counters.

Medical Imaging Systems
Medical display systems, medical thermography X-Ray, diathermy equipment. Ultrasonics in biomedical application for diagnostic and therapeutic, CAT, MRI, Laser applications in biomedical field.

Patient safety
Electrical Safety of Medical Equipments, Shock Hazards from Electrical Equipment, Methods of Accident Prevention, Test Instruments for checking Safety parameters of biomedical equipments.

LABORATORY / FIELD EXPERIENCES
1. Study of sensors and transducers used in Bio-medical applications
2. Study of Bio Medical instruments used in Heart-care system
3. Study of operation and maintenance of ECG instrument
4. Study of operation and maintenance of instruments used for thermography
5. Study of operation and maintenance of instruments used for blood analysis
6. Case study of operation and maintenance of an ultrasonic machine

BOOKS RECOMMENDED
1. Biomedical Instrumentation and Measurements; L.C. Cronwell F.J. Weibell. E.A. Pfeiffer, PHI.
REGULATIONS FOR TWO YEARS REGULAR (Four Semesters) M.E. and M.Tech. COURSES BEING OFFERED UNDER PANJAB UNIVERSITY (FACULTY OF ENGINEERING AND TECHNOLOGY) w.e.f. ACADEMIC SESSION 2011-2012

1. General
1.1 The duration of the course of instruction for M.E. and M.Tech. in all available disciplines being offered by the Panjab University, shall be two years (comprising of four semesters, with two semesters per year). Each semester shall be at least of fourteen weeks duration.

1.2 The subjects to be studied in each semester will be as per the prescribed scheme of study for a particular course, indicating the minimum number of lectures to be delivered, distribution of marks in Major examination (End semester examination), Internal Assessment including two Minor examinations (Mid semester examinations) (Minor-I, Minor-II) etc. Each subject shall have specified number of credits associated with it. The medium of instruction and examination shall be English.

1.3 The mode of admission to the First semester course in any branch will be decided by the Syndicate. It will be open to a candidate, who has passed B.E. / B.Tech. examination or any other equivalent examination and experience as approved by the syndicate in the relevant discipline recognised by the Panjab University, Chandigarh. In case of M.Tech. Engineering Education, the eligibility for admission will be B.E./B.Tech./B.Pharma. OR Master’s Degree in Mathematics/Physics/Chemistry.

1.4 Provided that a candidate must have obtained a minimum CGPA of 6.75 or 60% marks (where % marks are awarded) in the qualifying examination i.e. B.E. / B.Tech. in the appropriate discipline or any other equivalent qualifying degree as approved by the syndicate for admission to the first year M.E. and M.Tech. courses in all the University Engineering Departments / Institutes. The candidates (under the open category seats) shall be admitted on the basis of OCET merit conducted by Panjab University, Chandigarh. Due credit will be given to GATE qualified candidates as applicable and approved by the syndicate.

1.4.1 Sponsored Candidates (Teachers / Working Professionals)
Qualifications and Experience for Admission to M.E. / M.Tech. :
(i) M.Tech. Engineering Education : A Bachelor’s Degree in Engineering / Technology / Pharmacy from a recognised University or its equivalent OR Master’s Degree in Mathematics / Physics / Chemistry from a recognised University with atleast 50 % marks in aggregate and post qualification experience of atleast 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

(ii) M.E. Manufacturing Technology : A Bachelor’s Degree in Manufacturing Engineering / Mechanical Engineering / Production Engineering / Industrial Engineering / Automobile Engineering from a recognised University or its equivalent with atleast 50 % marks in
aggregate and post qualification experience of at least 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

(iii) M.E. Construction Technology and Management: A Bachelor’s Degree in Civil Engineering from a recognised University or its equivalent with at least 50% marks in aggregate and post qualification experience of at least 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

(iv) M.E. Computer Science and Engineering: A Bachelor’s Degree in Computer Science and Engineering / Electronics Engineering / Electrical Engineering / Instrumentation and Control Engineering / Information Technology from a recognised University or its equivalent with at least 50% marks in aggregate and post qualification experience of at least 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

(v) M.E. Instrumentation and Control: A Bachelor’s Degree in Electrical Engineering / Electronics Engineering / Instrumentation and Control Engineering from a recognised University or its equivalent with at least 50% marks in aggregate and post qualification experience of at least 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

(vi) M.E. Electronics and Communication Engineering: A Bachelor’s Degree in Electronics and Communication Engineering from a recognised University or its equivalent with at least 50% marks in aggregate and post qualification experience of at least 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

1.4.2 AICTE Sponsored QIP(Polytechnic) Scheme
Qualifications and Experience for Admission to M.E. / M.Tech.:
A Bachelor’s Degree in the appropriate branch with 50% marks and other eligibility criteria as prescribed by AICTE, New Delhi.

1.4.3 Admission Procedure
Sponsored Candidates
Merit list of all sponsored eligible candidates will be prepared based on the aggregate percentage of marks obtained in all the semesters / years of qualifying examination and the total experience. The admission will be granted to candidates strictly according to the merit list, prepared as follows:

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Multiplying Factor</th>
</tr>
</thead>
</table>

35
(a) % of marks in B.E./B.Tech. or its equivalent X 0.4
(b) % of marks in B.A./B.Sc. X 0.2
    Plus +
% of marks in M.A./M.Sc. X 0.2

Experience
One mark for each number of completed year of experience on the last day of receiving application gained after obtaining minimum entry qualification subject to a maximum of ten marks. Experience against leave vacancy, visiting / guest faculty will not be counted.

General Candidates
For general candidates, merit list will be prepared as per Panjab University, Chandigarh guide lines.

1.5 1st and 3rd semester examinations (End semester / major examinations) will usually be held in the month of November/December and 2nd and 4th semester examinations (End semester / major examinations) will be held in the month of May/June every year or on such other dates as may be fixed by the Syndicate. Besides, for improvement of “E” Grade only, examination for such candidates shall be conducted within one month of the last end term examination in which the candidate had secured ‘E’ Grade in a particular subject.

1.6 There shall be at least ten lectures/tutorials/practical/drawing classes during the semester, for every hour of lecture/tutorial/practical per week i.e. for each credit assigned to a subject shown in the schedule of teaching.

1.7 A student shall be eligible to appear in the examination only if he/she has attended at least 85% of the total classes held as mentioned above during the semester. The attendance shall be certified by the Chairperson of the University Department(s) / Director of Institute / Principal of College as the case may be.

1.8 On the recommendations of the Chairperson of the University Department(s) / Director of Institute / Principal of College as the case may be, Board of Control will have the power to condone the shortage of the attendance up to 10% per subject only as per the merit of each case.

1.9 A candidate who does not fulfil the attendance requirements in any subject will have to repeat the course of instruction in that subject.

1.10 A candidate will be promoted to second year only if he has earned at least 25 credits in first year (at least 10 credits in first semester) with a minimum CGPA of 6.0.

1.11 A candidate will be required to pass in all the subjects of M.E. / M.Tech. course, where minimum pass grade /satisfactory grade is prescribed in a maximum duration of three academic years, comprising of six registered semesters counted from academic session in which candidate is first admitted in M.E. / M.Tech. program. If a candidate fails to pass the examination in the period of three academic years, his/ her candidature will stand automatically cancelled. This period of three academic years will also include the entire period of duration.
which he/she had suspended his/her studies on his/her own or has failed in the examination or debarred by the Panjab University, Chandigarh from taking any examination.

1.12 If an error is detected in the grades despite every possible care having been exercised, the teacher-in-charge will bring the fact to the notice of the Chairperson of University Department(s) / Director of Institute / Principal of College as the case may be for its being placed before the competent authority appointed for the purpose by the university like Board of Control or equivalent. If the Board of Control approves the change, then revised grades shall be submitted to the University duly countersigned by the members of the Board of Control and Chairperson of University Department(s) / Director of Institute / Principal of College as the case may be for consideration within a maximum period of seven working days from the date of declaration of the result.

1.13 In case of any grievance, the candidate can always represent before the Board of Control.

1.14 A detailed grade card will be issued to each candidate for each semester. A candidate will be awarded the degree of M.E. / M.Tech. in respective discipline on earning minimum number of prescribed credits {corresponding to core + electives (departmental + open) + other allied subjects} as prescribed in the scheme of study. The minimum **C.G.P.A of 6.0** is required to qualify for the award of M.E. / M.Tech. degree.

1.15 A candidate with CGPA of 8.5 and above will be awarded M.E. / M.Tech. degree with honours.

1.16 Fee for appearing in each semester examination will be as prescribed by the Syndicate / Senate from time to time. Any candidate who is required to improve upon “E” grade after each End term examination shall have to pay required re-examination fee as prescribed by the Syndicate / Senate from time to time. Any candidate who obtains “F” grade in a subject will have to repeat the subject subsequently and registration / admission fee shall have to be paid by the candidate as prescribed by the Syndicate / Senate.

2.0 **Credit System**

2.1 All M.E. / M.Tech. programmes are organised around semester-based credit system of study. The credit system is based on continuous evaluation of a student’s performance / progress and includes flexibility to allow a student to progress at an optimum pace suited to his / her ability or convenience, subject to fulfilling minimum requirements for continuation.

2.2 Performance / progress of a student is measured by the number of credits that he / she has earned (completed satisfactorily). Based on the course credits and grades obtained by the student, grade point average is calculated. A minimum grade point average is required to be maintained for satisfactory progress and continuation in the programme. Also a minimum number of earned credits and a minimum grade point average should be acquired in order to qualify for the degree.

2.3 **Course Credit Assignment:**
Each course has a certain number of credits assigned to it depending on the associated number of lecture, tutorials and laboratory contact hours in a week. A few courses are without credit and are referred to as non-credit (NC) courses.

Lectures and Tutorials: One lecture hour or one tutorial hour per week per semester is assigned one credit.

Practical / Laboratory Work: One laboratory hour per week per semester is assigned half credit.

The credits are rounded off to the nearest whole number.

For each lecture or tutorial, the self study component is 1 hour/week.

2.4 Earning Credits:

At the end of every course, a letter grade is awarded in each course for which a student had registered. On obtaining a pass grade (at least ‘D’ grade), the student accumulates the course credits as earned credits. Performance of a student is measured by the number of credits that he/she has earned and by the weighted grade point average. A student has the option of auditing some courses. Grades obtained in these audit courses are not counted towards the calculation of grade point average. However, a pass grade (‘D’ grade) is essential for earning credits from an audit course.

3.0 Grading System

3.1 Relative standing of the student in the class shall be clearly indicated by his/her grades. The process of awarding grades shall be based upon fitting performance of the class to a defined statistical model.

3.2 The grades and their respective description, along with grade points are listed in the table-1 given below:

**Table - 1**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Grade Point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>10</td>
<td>Outstanding</td>
</tr>
<tr>
<td>A</td>
<td>9</td>
<td>Excellent</td>
</tr>
<tr>
<td>B+</td>
<td>8</td>
<td>Very Good</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>C+</td>
<td>6</td>
<td>Average</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>Below average</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>Marginal</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
<td>Poor</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>Very Poor</td>
</tr>
<tr>
<td>I</td>
<td>-</td>
<td>Incomplete</td>
</tr>
<tr>
<td>NP</td>
<td>-</td>
<td>Audit Pass</td>
</tr>
<tr>
<td>NF</td>
<td>-</td>
<td>Audit Fail</td>
</tr>
<tr>
<td>W</td>
<td>-</td>
<td>Withdrawal</td>
</tr>
<tr>
<td>X</td>
<td>-</td>
<td>Unsatisfactory (For courses involving Independent Study like Projects, Thesis, Seminar, Presentations, etc.)</td>
</tr>
<tr>
<td>S</td>
<td>-</td>
<td>Satisfactory Completion (For courses involving Independent Study like Projects, Thesis, Seminar, Presentations, etc.)</td>
</tr>
<tr>
<td>Z</td>
<td>-</td>
<td>Course continuation</td>
</tr>
</tbody>
</table>
3.3 Description of Grades:

A+ Grade: An A+ grade stands for outstanding achievement. Under any circumstances, A+ grade shall not be awarded for percentage of marks less than 80. There will not be more than 10% A+ grade in any course.

D Grade: The D grade stands for marginal performance. It is the minimum passing grade in any course. D grade shall not be awarded for percentage of marks less than 40 in any case. Still further, no student having 40 percent or more marks would be awarded failing grades of E and F.

E and F Grades: The E and F grades denote poor and very poor performance i.e. failing the course. F grade is also awarded in case of poor class / lab attendance (< 85%). A student has to repeat all the core courses in which he / she has obtained E or F grade, until a passing grade is obtained. In case of optional courses (Elective courses) the candidate may take the same course or some other course from the same category. An E grade in a course makes a student eligible to repeat the course in the summer / winter semester break i.e. the time period between the last end term examination and the start of next semester. The repeat end term examination (of three hours duration) for E-grade holders shall be conducted immediately after the last regular end term examination in the course within one month (before the start of next regular semester). For such candidates, the grade calculations will be based on the % class mean and % class standard deviation in that subject during his / her first attempt (i.e. regular attempt) in the particular course. Further, E and F grades secured in any course stay permanently on the grade card. Candidates obtaining F grade in a course will have to repeat the course. These grades are not counted in the calculation of CGPA; however, these are counted in the calculation of SGPA.

In case a candidate with E grade in a course (obtained during first attempt) is unable to get a passing grade during subsequent summer / winter break examination (i.e. second attempt, where the grade calculations will be based on the % class mean and % class standard deviation in that subject during his / her first attempt) in a particular course may be allowed one more chance (third attempt) during immediate next summer / winter break examination for the particular subject. However, the grade calculations will be based on the immediate available % class mean and % class standard deviation in that subject (which may not be the same as was valid during his / her second attempt). In case the candidate fails to secure a pass grade during his / her third attempt also, shall have to repeat the course.

I Grade: An I grade denotes incomplete performance in any L(lecture), P (practical), V(special module) category courses. It may be awarded to a student if he / she has not fulfilled all the requirements of the course due to some extra-ordinary circumstances. I grade does not appear permanently in the grade card. Upon completion of all course requirements, the I grade is converted to regular grade (A to F, NP or NF).

NP and NF Grades: These grades are awarded in a course that the student opts to audit. Audit pass grade (NP) is awarded if the student’s attendance is above 85% in the class and has obtained at least D grade. If either of these requirements is not fulfilled, audit fail (NF) grade is awarded. The grades obtained in an audit course are not considered in the calculation of SGPA or CGPA.
**W Grade:** A W grade is awarded in a course where the student has opted to withdraw from the course. Withdrawal from the course is permitted until one week after the first minor test.

**X Grade:** The X grade is awarded for incomplete \ unsatisfactory \ work in independent study like thesis work, project work, field work, industrial training, etc.

**S Grade:** The S grade is awarded for complete \ satisfactory \ work in independent study like thesis work, project work, field work, industrial training, etc.

### 4.0 Evaluation System

**Equal weightage will be given to internal assessment (Sessional) and End Semester Examination (Major Examination).**

#### 4.1 Continuous Assessment:

There shall be continuous evaluation of the student during the semester. For evaluation purpose, total marks assigned to each subject shall be distributed as:

- **(a) Internal Assessment (Sessional)**
  - Two mid-semester Examinations (Minor-1 and Minor-2) with **60 % of total sessional marks** assigned to the subject.
  - Assignments / Class projects / short class test / MCQ based quiz / projects / presentations / group discussions with **40 % of total sessional marks** assigned to the subject.

- **(b) End Semester Examination (Theory)**
  - One End Semester Examination (Major Examination)

Total score on a scale of 100 \ i.e. in % obtained by a student in a subject \ shall be henceforth referred as raw score in that subject.

Following the concept of relative grading, before assigning the letter grades, scientific normalization method shall be followed.

#### 4.2 Statistical Method for the Award of Grades:

For the award of grades in a course, all component wise evaluation shall be done in terms of marks. The components include: Midterm-1 and Midterm-2 examinations, Assignments / projects / class presentations / Attendance and End semester examination as per regulation 4.1. After converting the marks obtained in percentage, the grades will be assigned as per the guidelines given below:

- **4.2.1** For less than 15 students in a course, the grades shall be awarded on the basis of cut-off in the absolute marks as shown in Table-2

#### Table-2

<table>
<thead>
<tr>
<th>Absolute marks in % (Lower Limit)</th>
<th>Grade</th>
<th>Absolute marks in % (Upper Limit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>&lt; A+</td>
<td>&lt; 100</td>
</tr>
<tr>
<td>82</td>
<td>&lt; A</td>
<td>&lt; 90</td>
</tr>
<tr>
<td>73</td>
<td>&lt; B+</td>
<td>&lt; 81</td>
</tr>
<tr>
<td>64</td>
<td>&lt; B</td>
<td>&lt; 72</td>
</tr>
<tr>
<td>55</td>
<td>&lt; C+</td>
<td>&lt; 63</td>
</tr>
<tr>
<td>46</td>
<td>&lt; C</td>
<td>&lt; 54</td>
</tr>
<tr>
<td>40</td>
<td>&lt; D</td>
<td>&lt; 45</td>
</tr>
<tr>
<td>35</td>
<td>&lt; E</td>
<td>&lt; 39</td>
</tr>
</tbody>
</table>
4.2.2 For more than 30 students in a course, the statistical method shall be used for the award of grades. After expressing the score obtained by the students in a course in percentage (X), the class mean (\( \bar{X} \)) and class standard deviation (S) of the marks shall be calculated and grades shall be awarded to a student as shown in Table-3.

If X is the raw score in %; \( \bar{X} \) is class mean in % and S is class standard deviation in % (based on raw score), N is the number of students in a course, then for the course:

\[
\bar{X} = \frac{\text{Sum of all scores}}{\text{Number of Scores}} = \frac{\sum X_i}{N}
\]

\[
S = \sqrt{\frac{\sum (X_i - \bar{X})^2}{N}}
\]

**Table-3**

<table>
<thead>
<tr>
<th>Lower Range of Marks (%)</th>
<th>Grade Assigned</th>
<th>Upper Range of Marks (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \bar{X} + 25 )</td>
<td>( \leq ) A+</td>
<td>( \leq ) ( \bar{X} + 25 )</td>
</tr>
<tr>
<td>( \bar{X} + 15.5 )</td>
<td>( \leq ) A</td>
<td>( \leq ) ( \bar{X} + 15.5 )</td>
</tr>
<tr>
<td>( \bar{X} + 15 )</td>
<td>( \leq ) B+</td>
<td>( \leq ) ( \bar{X} + 15 )</td>
</tr>
<tr>
<td>( \bar{X} + 0.55 )</td>
<td>( \leq ) B</td>
<td>( \leq ) ( \bar{X} + 0.55 )</td>
</tr>
<tr>
<td>( \bar{X} )</td>
<td>( \leq ) C+</td>
<td>( \leq ) ( \bar{X} )</td>
</tr>
<tr>
<td>( \bar{X} - 0.55 )</td>
<td>( \leq ) C</td>
<td>( \leq ) ( \bar{X} - 0.55 )</td>
</tr>
<tr>
<td>( \bar{X} - 15 )</td>
<td>( \leq ) D</td>
<td>( \leq ) ( \bar{X} - 15 )</td>
</tr>
<tr>
<td>( \bar{X} - 15.5 )</td>
<td>( \leq ) E</td>
<td>( \leq ) ( \bar{X} - 15.5 )</td>
</tr>
<tr>
<td>( \bar{X} - 25 )</td>
<td>( &lt; ) F</td>
<td>( &lt; ) ( \bar{X} - 25 )</td>
</tr>
</tbody>
</table>

4.2.3 In case, class student strength in a course lies between 15 and 30, any of the above methods (given in 4.2.1 and 4.2.2) may be used for the award of grades.

4.3 Finalization of Grades:

Finalization of the grades shall be done by the Board of Control of the department / institute or appropriate body / committee approved by the university for the purpose.

In order to maintain a normal distribution in grades, following recommendations of UGC shall be kept in view and considered as broad guidelines by the Board of Control of the department / institute or appropriate body / committee approved by the university for the purpose.

<table>
<thead>
<tr>
<th>Grade</th>
<th>% of Population</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>Includes A(+) and A</td>
</tr>
<tr>
<td>B</td>
<td>24</td>
<td>Includes B(+) and B</td>
</tr>
<tr>
<td>C</td>
<td>38</td>
<td>Includes C(+) and C</td>
</tr>
<tr>
<td>D</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>
5.0 Evaluation of Performance

5.1 The performance of a student shall be evaluated in terms of two indices, viz. Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA). SGPA is the grade point average for the semester and CGPA is the cumulative grade point average for all the completed semesters at any point in time. The earned credits (EC) are defined as the sum of course credits for course in which A+ to D grade has been obtained. For U.G students (B.E.), credits from courses in which NP or S grade has been obtained are also added.

Points earned in a semester = \[ \sum \text{(Course Credits} \times \text{Grade Points}) \text{for courses in which A+ to D grade has been obtained} \]

The SGPA is calculated on the basis of grades obtained in all courses, except audit courses and courses in which S/Z grade is awarded, registered for the particular semester.

\[
SGPA = \frac{\sum \text{(Course Credits} \times \text{Grade Points}) \text{for all courses except audit and S/Z grade Courses}}{\sum \text{Course Credits} \text{ except audit and S/Z grade Courses}}
\]

The CGPA is calculated on the basis of all pass grades, except audit courses and courses in which S/Z grade is awarded, obtained in all completed semesters.

\[
CGPA = \frac{\sum \text{(Course Credits} \times \text{Grade Points}) \text{for all courses with pass grade except audit and S/Z grade Courses}}{\sum \text{Course Credits earned} \text{ except audit and S/Z grade Courses}}
\]

5.2 Example for the calculation of SGPA and CGPA

<table>
<thead>
<tr>
<th>Semester-I</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Column 1</strong></td>
<td><strong>Column 2</strong></td>
<td><strong>Column 3</strong></td>
<td><strong>Column 4</strong></td>
<td><strong>Column 5</strong></td>
<td><strong>Column 6</strong></td>
</tr>
<tr>
<td><strong>Course Code</strong></td>
<td><strong>Assigned Course Credits</strong></td>
<td><strong>Grade Awarded</strong></td>
<td><strong>Earned Credits</strong></td>
<td><strong>Grade Point (GP)</strong></td>
<td><strong>Points Secured</strong></td>
</tr>
<tr>
<td>PH101</td>
<td>5</td>
<td>C(+)</td>
<td>5</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>AM101</td>
<td>4</td>
<td>C</td>
<td>4</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>ME101</td>
<td>4</td>
<td>A(+)</td>
<td>4</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>EE101</td>
<td>2</td>
<td>B(+)</td>
<td>2</td>
<td>8</td>
<td>16</td>
</tr>
</tbody>
</table>
Credits registered in the semester (= sum total of column 2) = 21
Credits registered in the semester excluding audit and S/Z grade courses = 21-2 = 19
Earned credits in the semester (= sum total of column 4) = 17
Earned credits in the semester excluding audit and S/Z grade courses = 17-2 = 15
Points secured in this semester ( = sum total of column 6) = 114
Points secured in this semester in all passed courses ( = sum total of column 6 with only A to D grades) = 114-08 = 106

**SGPA**

\[
SGPA = \frac{\text{Points Secured in the Semester}}{\text{Credits Registered the Semester, excluding audit and } S/Z \text{ grade courses}}
\]

\[
= \frac{114}{19} = 6.000
\]

\[
CGPA = \frac{\text{Cumulative points secured in all passed courses (A(+) to D Grade)}}{\text{Cumulative earned credits, excluding audit and } S/Z \text{ grade courses.}}
\]

\[
= \frac{106}{15} = 7.067
\]

 Semester Performance : Earned Credits (E.C) = 17, with SGPA = 6.000
Cumulative performance : Earned Credits (E.C) = 17, with CGPA = 7.067

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>Assigned Course Credits</td>
<td>Grade Awarded</td>
<td>Earned Credits</td>
<td>Grade Point (GP)</td>
<td>Points Secured</td>
</tr>
<tr>
<td>CY202</td>
<td>5</td>
<td>B(+)</td>
<td>5</td>
<td>8</td>
<td>40</td>
</tr>
<tr>
<td>AM201</td>
<td>4</td>
<td>A</td>
<td>4</td>
<td>9</td>
<td>36</td>
</tr>
<tr>
<td>ME201</td>
<td>4</td>
<td>W</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>ME250</td>
<td>2</td>
<td>B</td>
<td>2</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>CY201</td>
<td>4</td>
<td>C(+)</td>
<td>4</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>CH201</td>
<td>4</td>
<td>A(+)</td>
<td>4</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>HU201</td>
<td>1</td>
<td>S</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>20</td>
<td></td>
<td></td>
<td>154</td>
</tr>
</tbody>
</table>

Credits registered in the semester (= sum total of column 2) = 24
Credits registered in the semester excluding audit and S/Z grade courses = 24-1 = 23
Earned credits in the semester (= sum total of column 4) = 20
Earned credits in the semester excluding audit and S/Z grade courses = 20-1 = 19
Points secured in this semester ( = sum total of column 6) = 154
Points secured in this semester in all passed courses ( = sum total of column 6 with only A to D grades) = 154-0 = 154
Cumulative points earned in all passed courses till date ( all past semesters + current semester) = 106+154 = 260
Cumulative earned credits till date (Earned credits in all past semesters + Earned Credits in the current semester) = 17 + 20 = 37

**SGPA**

\[
SGPA = \frac{Points \text{ Secured in the Semester}}{Credits \text{ Registered the Semester, excluding audit and } 5\% \text{ grade courses}}
\]

\[
= \frac{195}{19} = 8.105
\]

\[
CGPA = \frac{Cumulative \text{ points secured in all passed courses (A(+) to D Grade)}}{Cumulative \text{ earned credits, excluding audit and } 5\% \text{ grade courses.}}
\]

\[
= \frac{(105+15)}{34} = \frac{260}{34} = 7.647
\]

Semester Performance: Earned Credits (E.C) = 20, with SGPA = 8.105
Cumulative performance: Earned Credits (E.C) = 37, with CGPA = 7.647

5.3 Degree Requirements:

For Two year (Four Semesters) M.E. / M.Tech. programmes, the requirements are:

(i) Minimum Earned credits: completion of 75 earned credits including 25 credits assigned to thesis work to be carried out during third and fourth semester.

These credits are needed to be earned under different categories as specified for each programme in the scheme of study.

(ii) Cumulative Grade Point Average (CGPA) requirements:

A student must obtain Cumulative Grade Point Average (CGPA) of 6.0 and successful completion of thesis work to be eligible for the award of M.E. / M.Tech. degree.

5.4 Degree requirements for Post Graduate programmes in Engineering (Two year M.E. / M.Tech. programme)

<table>
<thead>
<tr>
<th>Category</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG (Core)</td>
<td>40</td>
</tr>
<tr>
<td>PG (Elective)</td>
<td>10</td>
</tr>
<tr>
<td>PG Thesis</td>
<td>25</td>
</tr>
</tbody>
</table>

5.5 Total Requirement for two year M.E. / M.Tech. programme for successful completion = atleast 75 credits {PG (Core) + PG (Elective) + Thesis} with minimum C.G.P.A of 6.0.

5.6 Maximum permissible number of registered semesters for completing M.E. / M.Tech. degree requirements are: 06 registered semesters.

If the performance at the end of first two registered semesters is very poor, then the registration will be terminated. If the performance is poor but not very poor, then the student can opt to start afresh, or else his / her registration will be terminated. The criteria for “very poor” and “poor” performance are:

<table>
<thead>
<tr>
<th>Performance</th>
<th>Earned Credits</th>
<th>Decision</th>
<th>registration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very poor</td>
<td>&lt;= 10 for GE/OBC ; &lt;= 8 for SC/ST/PH</td>
<td>Termination</td>
<td>of</td>
</tr>
</tbody>
</table>

44
Poor                    10 to 25 for GE/OBC; 8-20 for SC/ST/PH       Restart (once only) or Termination of registration

(i) If a student chooses to restart after first two registered semesters, then his or her credits earned and semesters registered will not be carried over. The re-start will be indicated on the transcript. The restart will be permitted only once. If at the end of two registered semesters after re-start, the earned credits are <= 25 for GE/OBC or <= 20 for SC/ST/PH students, then the registration will be terminated.

(ii) Each student is expected to earn atleast 10 credits in the first registered semester and 15 credits in each subsequent registered semesters with SGPA >= 6.0. If the performance of a student at the end of any registered semester is below this minimum acceptable level, then he / she will be placed on probation and a warning shall be issued to him / her and parents shall also be informed accordingly.

(iii) The student placed on probation shall be monitored, including mandatory class attendance, special tutorials and mentoring. Mentoring shall include specific guidance under a faculty member / PG student / research scholar.

(iv) The registration of any student will be limited to 1.5 times the average earned credits of the previous two registered semesters, subject to a minimum of 15 credits and a maximum of 25 credits.

5.7 CGPA is a Cumulative Grade Point Average. For the purpose of admission to all PG and Ph.D. engineering programmes at Panjab University, the following conversion table will be used:

<table>
<thead>
<tr>
<th>% Marks</th>
<th>10 point scale</th>
<th>9-point scale</th>
<th>6-point scale</th>
<th>4-point scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>6.25</td>
<td>4.78</td>
<td>3.19</td>
<td>2.13</td>
</tr>
<tr>
<td>60</td>
<td>6.75</td>
<td>5.34</td>
<td>3.56</td>
<td>2.38</td>
</tr>
<tr>
<td>70</td>
<td>7.50</td>
<td>6.19</td>
<td>4.13</td>
<td>2.75</td>
</tr>
</tbody>
</table>

Note:

1. Paper setting for End term examination (Major Examination or End semester examination) shall continue to be as per the procedure in place at present till any further modification is introduced.

2. There shall be no “special reappear examination”.

3. Subject wise result in the form of grades awarded to each student at the end of each semester shall be prepared by the respective departments / institutes / college / center and sent to the university examination branch for the declaration of result and issuance of grade cards.
4. Course teacher should display the grades awarded to the students on the notice board after showing the answer scripts to the students within five working days. The process of evaluation should invariably be completed within seven days from the date of conduct of examination.

5. Whenever required, CGPA (based on 10 point scale) may be converted into equivalent marks as below:

<table>
<thead>
<tr>
<th>Grade Point</th>
<th>Equivalent Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.25</td>
<td>55%</td>
</tr>
<tr>
<td>6.75</td>
<td>60%</td>
</tr>
<tr>
<td>7.25</td>
<td>65%</td>
</tr>
<tr>
<td>7.75</td>
<td>70%</td>
</tr>
<tr>
<td>8.25</td>
<td>75%</td>
</tr>
</tbody>
</table>

(\text{\%\,Marks} = 10\times\text{CGPA}-7.5)
1. General

1.1 The duration of the course of instruction for M.E. and M.Tech. in all available disciplines being offered by the Panjab University, shall be three and a half years (comprising of seven spells, with two spells per year). Each spell shall be at least of five weeks duration and the candidate can study maximum two theory subjects and one laboratory / pre-thesis / thesis work.

1.2 The subjects to be studied in each spell will be as per the prescribed scheme of study for a particular course, indicating the minimum number of lectures to be delivered, distribution of marks in Major examination (End term examination), Internal Assessment including one Minor examination (End spell examination). Each subject shall have specified number of credits associated with it. The medium of instruction and examination shall be English.

1.3 The mode of admission to the First Spell course in any branch will be decided by the Syndicate. It will be open to a candidate, who has passed B.E. / B.Tech. examination or any other equivalent examination as approved by the syndicate in the relevant discipline recognised by the Panjab University, Chandigarh. In case of M.Tech. Engineering Education, the eligibility for admission will be B.E./B.Tech./B.Pharma. OR Master’s Degree in Mathematics/Physics/Chemistry.

1.4 Provided that a candidate must have obtained a minimum CGPA of 6.75 or 60% marks (where % marks are awarded) in the qualifying examination i.e. B.E. / B.Tech. in the appropriate discipline or any other equivalent qualifying degree as approved by the syndicate for admission to the first year M.E. and M.Tech. courses in all the University Engineering Departments / Institutes. The candidates (under the open category seats) shall be admitted on the basis of OCET merit conducted by Panjab University, Chandigarh. Due credit will be given to GATE qualified candidates as applicable and approved by the syndicate.

1.4.1 Sponsored Candidates (Teachers / Working Professionals)

Qualifications and Experience for Admission to M.E. / M.Tech. :

(i) M.Tech. Engineering Education : A Bacher’s Degree in Engineering / Technology / Pharmacy from a recognised University or its equivalent OR Master’s Degree in Mathematics / Physics / Chemistry from a recognised University with atleast 50 % marks in aggregate and post qualification experience of atleast 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

(ii) M.E. Manufacturing Technology : A Bachelor’s Degree in Manufacturing Engineering / Mechanical Engineering / Production Engineering / Industrial Engineering / Automobile Engineering from a recognised University or its equivalent with atleast 50 % marks in
aggregate and post qualification experience of at least 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

(iii) M.E. Construction Technology and Management: A Bachelor’s Degree in Civil Engineering from a recognised University or its equivalent with at least 50% marks in aggregate and post qualification experience of at least 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

(iv) M.E. Computer Science and Engineering: A Bachelor’s Degree in Computer Science and Engineering / Electronics Engineering / Electrical Engineering / Instrumentation and Control Engineering / Information Technology from a recognised University or its equivalent with at least 50% marks in aggregate and post qualification experience of at least 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

(v) M.E. Instrumentation and Control: A Bachelor’s Degree in Electrical Engineering / Electronics Engineering / Instrumentation and Control Engineering from a recognised University or its equivalent with at least 50% marks in aggregate and post qualification experience of at least 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

(vi) M.E. Electronics and Communication Engineering: A Bachelor’s Degree in Electronics and Communication Engineering from a recognised University or its equivalent with at least 50% marks in aggregate and post qualification experience of at least 2 years (3 years in case of AMIE) in teaching / industry / research organisation.

1.4.2 Admission Procedure

Sponsored Candidates

Merit list of all sponsored eligible candidates will be prepared based on the aggregate percentage of marks obtained in all the semesters / years of qualifying examination and the total experience. The admission will be granted to candidates strictly according to the merit list, prepared as follows:

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Multiplying Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) % of marks in B.E./B.Tech. or its equivalent</td>
<td>X 0.4</td>
</tr>
<tr>
<td>(b) % of marks in B.A./B.Sc.</td>
<td>X 0.2</td>
</tr>
<tr>
<td>Plus</td>
<td>+</td>
</tr>
<tr>
<td>% of marks in M.A./M.Sc.</td>
<td>X 0.2</td>
</tr>
</tbody>
</table>
Experience

One mark for each number of completed year of experience on the last day of receiving application gained after obtaining minimum entry qualification subject to a maximum of ten marks. Experience against leave vacancy, visiting / guest faculty will not be counted.

General Candidates

For general candidates, merit list will be prepared as per Panjab University, Chandigarh guide lines.

1.5 1st and 3rd, spell examinations (End term / major examinations) will usually be held in the month of November / December and 2nd and 4th spell examinations (End term / Major examinations) will be held in the month of May / June every year or on such other dates as may be fixed by the Syndicate. Besides, for improvement of “E” Grade only, examination for such candidates shall be conducted within one month of the last end term examination in which the candidate had secured ‘E’ Grade in a particular subject.

1.6 There shall be at least ten hours of lectures/tutorials/practical/drawing classes during the spell, for every hour of lecture/tutorial/practical per week i.e. for each credit assigned to a subject shown in the schedule of teaching.

1.7 A student shall be eligible to appear in the examination only if he/she has attended at least 85% of the total classes held as mentioned above during the spell. The attendance shall be certified by the Chairperson of the University Department(s) / Director of Institute / Principal of College as the case may be.

1.8 On the recommendations of the Chairperson of the University Department(s) / Director of Institute / Principal of College as the case may be, Board of Control will have the power to condone the shortage of the attendance up to 10% per subject only as per the merit of each case.

1.9 A candidate who does not fulfil the attendance requirements in any subject will have to repeat the course of instruction in that subject.

1.10 A candidate must have earned 12 credits in the first two spells with minimum CGPA of 6.0 in order to continue in the fourth spell and the candidate must have earned 28 credits in the first four spells with minimum CGPA of 6.0 in order to continue in the sixth spell.

1.11 A candidate will be required to pass in all the subjects of M.E. / M.Tech. course, where minimum pass grade / satisfactory grade is prescribed in a maximum duration of 5½ academic years, comprising of eleven registered spells counted from academic session in which candidate is first admitted in M.E. / M.Tech. program. If a candidate fails to pass the examination in the period of 5½ academic years, his / her candidature will stand automatically cancelled. This period of 5½ academic years will also include the entire period of duration which he/she had suspended his/her studies on his/her own or has failed in the
examination or debarred by the Panjab University, Chandigarh from taking any
examination.

1.12 If an error is detected in the grades despite every possible care having been
exercised, the teacher-in-charge will bring the fact to the notice of the
Chairperson of University Department(s) / Director of Institute / Principal of
College as the case may be for its being placed before the competent authority
appointed for the purpose by the university like Board of Control or equivalent.
If the Board of Control approves the change, then revised grades shall be
submitted to the University duly countersigned by the members of the Board of
Control and Chairperson of University Department(s) / Director of Institute /
Principal of College as the case may be for consideration within a maximum
period of seven working days from the date of declaration of the result.

1.13 In case of any grievance, the candidate can always represent before the Board of
Control.

1.14 A detailed grade card will be issued to each candidate for each spell. A candidate
will be awarded the degree of M.E. / M.Tech. in respective discipline on earning
minimum number of prescribed credits (corresponding to core + electives
(departmental + open) + other allied subjects) as prescribed in the scheme of
study. The minimum **C.G.P.A of 6.0** is required to qualify for the award of M.E. /
M.Tech. degree

1.15 A candidate with CGPA of 8.5 and above will be awarded M.E. / M.Tech. degree
with honours.

1.16 Fee for appearing in each spell examination will be as prescribed by the Syndicate
/ Senate from time to time. Any candidate who is required to improve upon “E”
grade after each End term examination shall have to pay required re-examination
fee as prescribed by the Syndicate / Senate from time to time. Any candidate who
obtains “F” grade in a subject will have to repeat the subject subsequently and
registration / admission fee shall have to be paid by the candidate as prescribed by
the Syndicate / Senate.

2.0 **Credit System**

2.1 The M.E. / M.Tech. programmes are organised on credit system of study. The
credit system is based on continuous evaluation of a student’s performance / progress and
includes flexibility to allow a student to progress at an optimum pace suited to his / her
ability or convenience, subject to fulfilling minimum requirements for continuation.

2.2 Performance / progress of a student is measured by the number of credits that he /
she has earned (completed satisfactorily). Based on the course credits and grades
obtained by the student, grade point average is calculated. A minimum grade point
average is required to be maintained for satisfactory progress and continuation in the
programme. Also a minimum number of earned credits and a minimum grade point
average should be acquired in order to qualify for the degree.

2.3 Course Credit Assignment:

Each course has a certain number of credits assigned to it depending on the associated
number of lecture, tutorials and laboratory contact hours in a week. A few courses are
without credit and are referred to as non-credit (NC) courses.

Lectures: One lecture hour per week per spell is assigned one credit.
Practical / Laboratory Work / Tutorial : One laboratory hour / one tutorial hour per week per spell is assigned half credit.
The credits are rounded off to the nearest whole number.
For each lecture or tutorial, the self study component is 1 hour/week.

2.4 Earning Credits:
At the end of every course, a letter grade is awarded in each course for which a student had registered. On obtaining a pass grade (at least ‘D’ grade), the student accumulates the course credits as earned credits. Performance of a student is measured by the number of credits that he / she has earned and by the weighted grade point average. A student has the option of auditing some courses. Grades obtained in these audit courses are not counted towards the calculation of grade point average. However, a pass grade (‘D’ grade) is essential for earning credits from an audit course.

3.0 Grading System
3.1 Relative standing of the student in the class shall be clearly indicated by his / her grades. The process of awarding grades shall be based upon fitting performance of the class to a defined statistical model.
3.2 The grades and their respective description, along with grade points are listed in the table-1 given below:

Table - 1

<table>
<thead>
<tr>
<th>Grade</th>
<th>Grade Point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>10</td>
<td>Outstanding</td>
</tr>
<tr>
<td>A</td>
<td>9</td>
<td>Excellent</td>
</tr>
<tr>
<td>B+</td>
<td>8</td>
<td>Very Good</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>Good</td>
</tr>
<tr>
<td>C+</td>
<td>6</td>
<td>Average</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>Below average</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>Marginal</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
<td>Poor</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>Very Poor</td>
</tr>
<tr>
<td>I</td>
<td>-</td>
<td>Incomplete</td>
</tr>
<tr>
<td>NP</td>
<td>-</td>
<td>Audit Pass</td>
</tr>
<tr>
<td>NF</td>
<td>-</td>
<td>Audit Fail</td>
</tr>
<tr>
<td>W</td>
<td>-</td>
<td>Withdrawal</td>
</tr>
<tr>
<td>X</td>
<td>-</td>
<td>Unsatisfactory (For courses involving Independent Study like Projects, Thesis, Seminar, Presentations, etc.)</td>
</tr>
<tr>
<td>S</td>
<td>-</td>
<td>Satisfactory Completion (For courses involving Independent Study like Projects, Thesis, Seminar, Presentations, etc.)</td>
</tr>
<tr>
<td>Z</td>
<td>-</td>
<td>Course continuation</td>
</tr>
</tbody>
</table>
3.3 Description of Grades:

A+ Grade: An A+ grade stands for outstanding achievement. Under any circumstances, an A+ grade shall not be awarded for percentage of marks less than 80. There will not be more than 10% A+ grade in any course.

D Grade: The D grade stands for marginal performance. It is the minimum passing grade in any course. A D grade shall not be awarded for percentage of marks less than 40 in any case. Still further, no student having 40 percent or more marks would be awarded failing grades of E and F.

E and F Grades: The E and F grades denote poor and very poor performance i.e. failing the course. F grade is also awarded in case of poor class/lab attendance (< 85%). A student has to repeat all the core courses in which he/she has obtained E or F grade, until a passing grade is obtained. In case of optional courses (Elective courses) the candidate may take the same course or some other course from the same category. An E grade in a course makes a student eligible to repeat the course in the subsequent spell. For such candidates, the grade calculations will be based on the % class mean and % class standard deviation in that subject during his/her first attempt (i.e. regular attempt) in the particular course. Further, E and F grades secured in any course stay permanently on the grade card. Candidates obtaining F grade in a course will have to repeat the course. These grades are not counted in the calculation of CGPA; however, these are counted in the calculation of SpGPA.

In case a candidate with E grade in a course (obtained during first attempt) is unable to get a passing grade during subsequent examination (i.e. second attempt, where the grade calculations will be based on the % class mean and % class standard deviation in that subject during his/her first attempt) in a particular course may be allowed to take any other alternative subject as per approved scheme. The grade calculations will be based on the immediate available % class mean and % class standard deviation in that subject (which may not be the same as was valid during his/her second attempt). In case the candidate fails to secure a pass grade in the alternative subject, he/she will have to repeat the subject.

I Grade: An I grade denotes incomplete performance in any L(lecture), P(practical), V(special module) category courses. It may be awarded to a student if he/she has not fulfilled all the requirements of the course due to some extraordinary circumstances. I grade does not appear permanently in the grade card. Upon completion of all course requirements, the I grade is converted to regular grade (A to F, NP or NF).

NP and NF Grades: These grades are awarded in a course that the student opts to audit. Audit pass grade (NP) is awarded if the student’s attendance is above 85% in the class and has obtained at least D grade. If either of these requirements is not fulfilled, audit fail (NF) grade is awarded. The grades obtained in an audit course are not considered in the calculation of SpGPA or CGPA.

W Grade: A W grade is awarded in a course where the student has opted to withdraw from the course. Withdrawal from the course is permitted until one week after the first minor test.

X Grade: The X grade is awarded for incomplete/unsatisfactory work in independent study like thesis work, project work, field work, industrial training, etc.

S Grade: The S grade is awarded for complete/satisfactory work in independent study like thesis work, project work, field work, industrial training, etc.

4.0 Evaluation System
Equal weightage will be given to internal assessment (Sessional) and End Spell Examination (Major Examination).

4.1 Continuous Assessment:
There shall be continuous evaluation of the student during the spell. For evaluation purpose, total marks assigned to each subject shall be distributed as:

(a) Internal Assessment (Sessional)
One End spell Examination (Minor) with 60% of total sessional marks assigned to the subject.
Assignments / Class projects / short class test / MCQ based quiz / projects / presentations / group discussions with 40% of total sessional marks assigned to the subject.

(b) End Spell Examination (Theory)
One End Spell Examination (Major Examination)

Total score on a scale of 100 i.e. in % obtained by a student in a subject shall be hence forth referred as raw score in that subject.

Following the concept of relative grading, before assigning the letter grades, scientific normalization method shall be followed.

4.2 Statistical Method for the award of Grades:
For the award of grades in a course, all component wise evaluation shall be done in terms of marks. The components include: Minor examination, Assignments / projects / class presentations / Attendance and End spell examination as per regulation 4.1. After converting the marks obtained in percentage, the grades will be assigned as per the guidelines given below:

4.2.1 For less than 15 students in a course, the grades shall be awarded on the basis of cut-off in the absolute marks as shown in Table-2.

<table>
<thead>
<tr>
<th>Absolute marks in % (Lower Limit)</th>
<th>Grade</th>
<th>Absolute marks in % (Upper Limit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>91 &lt; 82 &lt; 73 &lt; 64 &lt; 55 &lt; 46 &lt; 40</td>
<td>A+ A  B+ B  C+ C  D  E  F</td>
<td></td>
</tr>
<tr>
<td>100 90 81 72 63 54 45 39 35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2.2 For more than 30 students in a course, the statistical method shall be used for the award of grades. After expressing the score obtained by the students in a course in percentage (X), the class mean (\( \bar{X} \)) and class standard deviation (S) of the marks shall be calculated and grades shall be awarded to a student as shown in Table-3.

If X is the raw score in %; \( \bar{X} \) is class mean in % and S is class standard deviation in % (based on raw score), N is the number of students in a course, then for the course:
\[
X = \frac{\text{Sum of all scores}}{\text{Number of Scores}} = \frac{\sum X_i}{N}
\]
\[
S = \sqrt{\frac{\sum (X_i - \bar{X})^2}{N}}
\]

Table-3

<table>
<thead>
<tr>
<th>Lower Range of Marks (%)</th>
<th>Grade Assigned</th>
<th>Upper Range of Marks (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\bar{X} + 2.5)</td>
<td>(\leq)</td>
<td>A+</td>
</tr>
<tr>
<td>(\bar{X} + 1.55)</td>
<td>(\leq)</td>
<td>A</td>
</tr>
<tr>
<td>(\bar{X} + 1.5)</td>
<td>(\leq)</td>
<td>B+</td>
</tr>
<tr>
<td>(\bar{X} + 0.55)</td>
<td>(\leq)</td>
<td>B</td>
</tr>
<tr>
<td>(\bar{X} + 0.5)</td>
<td>(\leq)</td>
<td>C+</td>
</tr>
<tr>
<td>(\bar{X} - 0.5)</td>
<td>(\leq)</td>
<td>C</td>
</tr>
<tr>
<td>(\bar{X} - 0.55)</td>
<td>(\leq)</td>
<td>D</td>
</tr>
<tr>
<td>(\bar{X} - 1.5)</td>
<td>(\leq)</td>
<td>E</td>
</tr>
<tr>
<td>(\bar{X} - 1.55)</td>
<td>(\leq)</td>
<td>F</td>
</tr>
<tr>
<td>(\leq)</td>
<td>(\leq)</td>
<td>(\bar{X} - 1.5)</td>
</tr>
<tr>
<td>(\leq)</td>
<td>(\leq)</td>
<td>(\bar{X} - 1.55)</td>
</tr>
</tbody>
</table>

4.2.3 In case, class student strength in a course lies between 15 and 30, any of the above methods (given in item 4.2.1 and 4.2.2) may be used for the award of grades.

4.3 Finalization of Grades:
Finalization of the grades shall be done by the Board of Control of the department / institute or appropriate body / committee approved by the university for the purpose.
In order to maintain a normal distribution in grades, following recommendations of UGC shall be kept in view and considered as broad guidelines by the Board of Control of the department / institute or appropriate body / committee approved by the university for the purpose.

<table>
<thead>
<tr>
<th>Grade</th>
<th>% of Population</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>Includes A(+) and A</td>
</tr>
<tr>
<td>B</td>
<td>24</td>
<td>Includes B(+) and B</td>
</tr>
<tr>
<td>C</td>
<td>38</td>
<td>Includes C(+) and C</td>
</tr>
<tr>
<td>D</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

*Note:* In case Board of Control of the department / institute or appropriate body / committee approved by the university for the purpose, is convinced on broad variations in grade distribution in a class for a particular subject, Board of Control may make some
minor variations in standard deviation, $S$ while maintaining the grade distribution as recommended by the UGC.

**5.0 Evaluation of Performance**

5.1 The performance of a student shall be evaluated in terms of two indices, viz. Spell Grade Point Average (SpGPA) and Cumulative Grade Point Average (CGPA). SpGPA is the grade point average for the spell and CGPA is the cumulative grade point average for all the completed spells at any point in time.

The earned credits (EC) are defined as the sum of course credits for course in which A+ to D grade has been obtained.

Points earned in a spell =

$$\sum (\text{Course Credits} \times \text{Grade Points}) \text{for courses in which A+ to D grade has been obtained}$$

The SpGPA is calculated on the basis of grades obtained in all courses, except audit courses and courses in which S/Z grade is awarded, registered for the particular spell.

$$\text{SpGPA} = \frac{\sum \text{(Course Credits} \times \text{Grade Points}) \text{for all courses except audit and S/Z grade Courses}}{\sum \text{(Course Credits)} \text{except audit and S/Z grade Courses}}$$

$$\text{SpGPA} = \frac{\sum \text{(Course Credits} \times \text{Grade Points})}{\sum \text{(Course Credits)} \text{except audit and S/Z grade Courses}}$$

**SGPA**

**Points Secured in the Semester**

Credits Registered the Semester, excluding audit and S/Z grade courses

The CGPA is calculated on the basis of all pass grades, except audit courses and courses in which S/Z grade is awarded, obtained in all completed spells.

$$\text{CGPA} = \frac{\sum (\text{Course Credits} \times \text{Grade Points}) \text{for all courses with pass grade except audit and S/Z grade Courses}}{\sum (\text{Course Credits earned}) \text{except audit and S/Z grade Courses}}$$

$$\text{CGPA} = \frac{\sum (\text{Course Credits earned})}{\sum (\text{Course Credits earned}) \text{except audit and S/Z grade Courses}}$$

5.2 Example for the calculation of SpGPA and CGPA

<table>
<thead>
<tr>
<th>Spell - I</th>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>Assigned Course Credits</td>
<td>Grade Awarded</td>
<td>Earned Credits</td>
<td>Grade Point (GP)</td>
<td>Points Secured</td>
<td></td>
</tr>
<tr>
<td>MMT6101</td>
<td>4</td>
<td>C</td>
<td>4</td>
<td>5</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>
Credits registered in the spell (= sum total of column 2) = 10
Credits registered in the spell excluding audit and S/Z grade courses = 10 - 0 = 10
Earned credits in the spell (= sum total of column 4) = 10
Earned credits in the spell excluding audit and S/Z grade courses = 10 - 0 = 10
Points secured in this spell ( = sum total of column 6) = 76
Points secured in this spell in all passed courses ( = sum total of column 6 with only A to D grades) = 76 - 0 = 76

\[ \text{SGPA} = \frac{\text{Points Secured in the Spell}}{\text{Credits Registered the Spell, excluding audit and S/Z grade courses}} \]
\[ = \frac{76}{10} = 7.60 \]

\[ \text{CGPA} = \frac{\text{Cumulative points secured in all passed courses (A(+) to D Grade)}}{\text{Cumulative earned credits, excluding audit and S/Z grade courses.}} \]
\[ = \frac{76}{10} = 7.60 \]

Spell Performance: Earned Credits (E.C) = 10, with SpGPA = 7.60
Cumulative performance: Earned Credits (E.C) = 10, with CGPA = 7.60

### Spell - II

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
<th>Column 5</th>
<th>Column 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Code</td>
<td>Assigned Course Credits</td>
<td>Grade Awarded</td>
<td>Earned Credits</td>
<td>Grade Point (GP)</td>
<td>Points Secured</td>
</tr>
<tr>
<td>MMT6102</td>
<td>4</td>
<td>A(+)</td>
<td>4</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>MMT6151</td>
<td>2</td>
<td>B(+)</td>
<td>2</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>10</td>
<td>76</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Credits registered in the spell (= sum total of column 2) = 10
Credits registered in the spell excluding audit and S/Z grade courses = 10
Earned credits in the spell (= sum total of column 4) = 6
Earned credits in the spell excluding audit and S/Z grade courses = 6 - 0 = 6
Points secured in this spell ( = sum total of column 6) = 38
Points secured in this spell in all passed courses ( = sum total of column 6 with only A to D grades) = 38 - 0 = 38
Cumulative points earned in all passed courses till date (all past spells + current spell) = 76 + 38 = 114
Cumulative earned credits till date (Earned credits in all past spells + Earned Credits in the current spell) = 10 + 6 = 16

\[ \text{SGPA} = \frac{\text{Points Secured in the Spell}}{\text{Credits Registered the Spell, excluding audit and S/Z grade courses}} \]
\[
\text{CGPA} = \frac{\text{Cumulative points secured in all passed courses (A+ to D Grade)}}{\text{Cumulative earned credits, excluding audit and 3/F grade courses.}}
\]
\[
= \frac{76 + 38}{10 + 06} = \frac{114}{16} = 7.125
\]

Spell Performance: Earned Credits (E.C) = 6, with SpGPA = 6.00
Cumulative Performance: Earned Credits (E.C) = 16, with CGPA = 5.25

5.3 Degree Requirements:
For Three and a half year (Seven Spells) M.E. / M.Tech. programmes, the requirements are:

(iii) Minimum Earned credits: completion of 75 earned credits including 25 credits assigned to thesis work to be carried out during fifth and seventh spell.

These credits are needed to be earned under different categories as specified for each programme in the scheme of study.

(iv) Cumulative Grade Point Average (CGPA) requirements:

A student must obtain Cumulative Grade Point Average (CGPA) of 6.0 and successful completion of thesis work to be eligible for the award of M.E. / M.Tech. degree.

5.4 Degree requirements for Post Graduate programmes in Engineering (M.E. / M.Tech. programme):

<table>
<thead>
<tr>
<th>Category</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG (Core)</td>
<td>40 (Min)</td>
</tr>
<tr>
<td>PG (Elective)</td>
<td>10 (Min)</td>
</tr>
<tr>
<td>PG Thesis</td>
<td>25</td>
</tr>
</tbody>
</table>

5.5 Total Requirements for M.E. / M.Tech. programme for successful completion = atleast 75 credits {PG (Core) + PG (Elective) + Thesis} with minimum C.G.P.A of 6.0.

5.6 Maximum permissible number of registered spells for completing M.E. / M.Tech. degree requirements are: 11 registered spells.

If the performance at the end of first two registered spells is very poor, then the registration will be terminated. If the performance is poor but not very poor, then the student can opt to start afresh, or else his / her registration will be terminated. The criteria for “very poor” and “poor” performance are:

<table>
<thead>
<tr>
<th>Performance</th>
<th>Earned Credits</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very poor</td>
<td>&lt;= 8 for GE/OBC/SC/ST/PH</td>
<td>Termination of registration</td>
</tr>
<tr>
<td>Poor</td>
<td>8 to 12 for GE/OBC/SC/ST/PH</td>
<td>Restart (once only) or Termination of registration</td>
</tr>
</tbody>
</table>

(v) If a student chooses to restart after first two registered spells, then his or her credits earned and spells registered will not be carried over. The re-start will be indicated on the transcript. The restart will be permitted only once. If at the end of two registered spells after re-start, the earned credits are <= 12 for GE/OBC/SC/ST/PH students, then the registration will be terminated.
(vi) Each student is expected to earn at least 8 credits in the first registered spell and 12 credits in each subsequent registered spell with SpGPA >= 6.0. If the performance of a student at the end of any registered spell is below this minimum acceptable level, then he/she will be placed on probation and a warning shall be issued to him/her and parents shall also be informed accordingly.

(vii) The student placed on probation shall be monitored, including mandatory class attendance, special tutorials and mentoring. Mentoring shall include specific guidance under a faculty member/PG student/research scholar.

(viii) The registration of any student will be limited to 10 credits in a registered spell for course work, excluding the credits for pre-thesis/thesis work.

5.7 CGPA is a Cumulative Grade Point Average. For the purpose of admission to all PG and Ph.D. engineering programmes at Panjab University, the following conversion table will be used:

<table>
<thead>
<tr>
<th>Equivalent GPA</th>
<th>% Marks</th>
<th>10 point scale</th>
<th>9-point scale</th>
<th>6-point scale</th>
<th>4-point scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>6.25</td>
<td>4.78</td>
<td>3.19</td>
<td>2.13</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>6.75</td>
<td>5.34</td>
<td>3.56</td>
<td>2.38</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>7.50</td>
<td>6.19</td>
<td>4.13</td>
<td>2.75</td>
<td></td>
</tr>
</tbody>
</table>

Note:
6. Paper setting for End term examination (Major Examination or End spell examination) shall continue to be as per the procedure in place at present till any further modification is introduced.

7. There shall be no “special reappear examination” for any student.

8. Subject wise result in the form of grades awarded to each student at the end of each spell shall be prepared by the respective departments/institutes/college/center and sent to the university examination branch for the declaration of result and issuance of grade cards.

9. Course teacher should display the grades awarded to the students on the notice board after showing the answer scripts to the students within seven working days. The process of evaluation should invariably be completed within ten days from the date of conduct of examination.

10. Whenever required, CGPA (based on 10 point scale) may be converted into equivalent marks as below:

<table>
<thead>
<tr>
<th>Grade Point</th>
<th>Equivalent Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.25</td>
<td>55%</td>
</tr>
<tr>
<td>6.75</td>
<td>60%</td>
</tr>
<tr>
<td>7.25</td>
<td>65%</td>
</tr>
<tr>
<td>7.75</td>
<td>70%</td>
</tr>
<tr>
<td>8.25</td>
<td>75%</td>
</tr>
</tbody>
</table>

( % Marks = 10*CGPA-7.5)