This text-book explains the fundamentals of NC/CNC machine tools, operations and part programming which form essential portion of course on Computer Aided Manufacturing (CAM). This book also covers advanced topics such as Macro programming, DNC and Computer Aided Part Programming (CAPP) in detail.

In this second revised and enlarged edition, all the chapters are reviewed and relevant topics, examples, part programs, sketches, review questions and exercises have been added to enhance the utility of the book.

This book is divided into 6 major areas.

Chapter 1 to 4 cover the history, fundamentals and structure of NC/CNC machine tools.

Chapter 5, 6 and 7 cover turning center programming in detail. Various turning canned cycles are discussed in depth with the help of illustrative examples.

Chapter 8 and 9 are devoted to machining center programming. Drilling canned cycles are discussed in detail with relevant examples.

Chapter 10 and 11 cover advanced topics of subprogramming and macro programming.

Chapter 12 deals with the communications and networking of NC/CNC machine tools.

Chapter 13 and 14 explain the advanced programming using APT and CAD/CAM based programming respectively.

The book contains:

- 258 Self explanatory and neatly drawn drawings
- 62 Solved part programming examples
- 37 Part programming exercises
- 173 Review questions at the end of all the chapters
- 101 Multiple choice questions.

It is the fervent hope of the authors that book will satisfy the needs of the Mechanical, Production, Mechatronics and Automobile Engineering students preparing for the B.Tech/B.E. examinations of all the Indian Universities, Diploma examinations conducted by various Boards of Technical Education, Certificate course as well as for the A.M.I.E., U.P.S.C., G.A.T.E., I.E.S. and other similar competitive and professional examinations. It should also be of an immense help to the practising Mechanical Engineers.
**Chapter 1  INTRODUCTION TO NC/CNC MACHINE TOOLS**

1-1. History of NC machines
1-2. Introduction to numerical control (NC) machine tools
   Definition
1-3. CNC (Computer Numerical Control)
   Machine control unit
1-4. Differences between NC and conventional machine tools
   (1) Spindle drives
   (2) Guideways
   (3) Motion transmission
   (4) Feed drives
   (5) Machine tool structure
   (6) Control unit
   (7) Feedback unit
   (8) Automatic tool changer (ATC)
   (9) Automatic pallet changer (APC)
1-5. Advantages of CNC over NC
   (1) Controller
   (2) Memory
   (3) Part program editing
   (4) Cutter compensation
   (5) Multitap canned cycles
   (6) Advance part programming
   (7) Tool path simulation
   (8) Conversational programming
   (9) Diagnostic
1-6. Advantages of NC and CNC over Conventional machine tools
   (1) Increased flexibility
   (2) More complex geometry
   (3) Higher production rate
   (i) Reduced set-ups
   (ii) Reduced lead time
   (iii) Reduced non-machining time
   (4) Higher accuracy and repeatability
   (5) Reduced inspection
   (6) Reduced operator skill
   (7) Reduced scrap
   (8) Reduced work-in-process inventory
   (9) Elimination of profile tools
   (10) Simpler fixtures
   (11) Optimum cutting conditions
1-7. Limitations of NC/CNC machine tools
   (1) Cost
   (2) High maintenance costs
   (3) Not cost effective for low production levels
   (4) Programming skill
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   (1) Axes system
   (2) Main spindle
   (3) Tool turret
   (4) Tail stock (with hydraulic quill)
   (5) Other Features
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   (2) Table
   (3) Headstock
   (4) ATC system
   (5) Special features
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   (2) Unconventional machining
   (3) Fabrication and welding
   (4) Press work
   (5) Material handling and assembly
   (6) Inspection and measurement
   (7) Wood working
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2-3-3. Part origin or part zero
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   (2) 45° path
   (3) Linear Path
2-4-2. Line control/straight cut control (L-type)
2-4-3. Continuous path control (C-type)
   (1) 2-D contouring control
   (2) 2½-D contouring control
   (3) 3-D contouring control
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   (2) Integral motor-spindle
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3-4. Guideways
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3-5-1. Recirculating ballscrews
   (1) Double nut preloading
   (2) Single nut preloading
3-5-2. Roller screw
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   (2) Gray code
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   (2) Tab sequential format
   (3) Word address format
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      (ii) Digits
      (iii) Operators
      (iv) Special characters

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   (1) ISO code
   (2) EIA code

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   (2) Photoelectric tape reader
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   (4) Magnetic tapes

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   (3) Miscellaneous code
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   (5) Feed word
   (6) Speed word
   (7) Tool number

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   (2) Spindle speed
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   (3) Radius of arc or center of arc

5-4. Tool compensations
   (1) Geometry offsets
   (2) Wear offsets
   (3) Tool nose radius compensation

5-4-1. Geometry offsets
5-4-2. Wear offset
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Step 2: Setup the manufacturing data base and operations
(1) Tooling data (2) Machine tools/work cells (3) Fixture setups (4) Operation setup
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