TABLE OF CONTENTS

PAGE

CHAPTER 1: VECTOR CALCULUS

1.0 INTRODUCTION 1

1.1 COORDINATE SYSTEMS 2

1.2 ADDITION AND SUBTRACTION OF VECTORS 6

1.3 PRODUCT OF VECTORS 7

1.4 VECTOR IDENTITIES 11

1.5 SCALAR AND VECTOR FUNCTIONS 12

1.6 THE DIFFERENTIAL OPERATOR 15

1.7 REPRESENTATION OF VECTORS IN OTHER COORDINATES 19

1.8 INTEGRALS OF SCALAR AND VECTOR FUNCTIONS 24

1.9 DIFFERENTIAL EXPRESSIONS IN OTHER COORDINATES 27

PROBLEMS 29

CHAPTER 2: STATIC ELECTRIC FIELD

2.0 INTRODUCTION 33

2.1 STATIC ELECTRIC CHARGES 35

2.2 COULOMB'S LAW 37

PAGE

2.3 CHARGE DENSITY DISTRIBUTIONS 41

2.4 STATIC ELECTRIC FIELD 47

2.5 ELECTRIC FIELD- CONTINUOUS LINE CHARGE DISTRIBUTION 51

2.6 ELECTRIC FIELD- CONTINUOUS SURFACE CHARGE DISTRIBUTION 58

2.7 ELECTRIC FIELD- CONTINUOUS VOLUME CHARGE DISTRIBUTION 65

2.8 SUMMARY 67

PROBLEMS 69

CHAPTER 3: ELECTRIC FLUX DENSITY

3.0 INTRODUCTION 72

3.1 GAUSS'S LAW FOR ELECTRIC FIELD 75

3.2 DIVERGENCE OF ELECTRIC FIELD 84

3.3 SUMMARY 92

PROBLEMS 93

CHAPTER 4: ELECTROSTATIC POTENTIAL

4.0 INTRODUCTION 95

4.1 WORK DONE AND ELECTRIC SCALAR POTENTIAL 96

4.2 STATIC ELECTRIC POTENTIAL IN TERMS OF SOURCES 98

4.3 ELECTRIC POTENTIAL- CONTINUOUS LINE CHARGE DISTRIBUTION 102

4.4 ELECTRIC POTENTIAL- CONTINUOUS SURFACE CHARGE DISTRIBUTION 109

4.5 ELECTRIC POTENTIAL- CONTINUOUS VOLUME CHARGE DISTRIBUTION 114

4.6 GRADIENT OF ELECTRIC SCALAR POTENTIAL 116

4.7 POISSON AND LAPLACE EQUATIONS 119

4.8 ELECTROSTATIC ENERGY 121

4.9 SUMMARY 128

PROBLEMS 130

CHAPTER 5: DIELECTRIC MATERIAL MEDIUM

5.0 INTRODUCTION 133

5.1 ELECTRIC POLARIZATION 134

PAGE

5.2 COULOMB'S LAW IN DIELECTRIC MEDIUM 144
5.3 ELECTRIC FLUX DENSITY 153
5.4 ELECTRIC SCALAR POTENTIAL 158
5.5 ENERGY STORED IN DIELECTRIC MEDIUM 164
5.6 CONDUCTING MATERIAL 166
5.7 BOUNDARY CONDITIONS 171
5.8 SUMMARY 179
PROBLEMS 181

CHAPTER 6: SOLUTION TO ELECTROSTATIC FIELD PROBLEMS

6.0 INTRODUCTION 183
6.1 ONE DIMENSIONAL PROBLEMS 186
6.2 CAPACITANCE OF PARALLEL PLATES 195
6.3 CAPACITANCE OF COAXIAL CYLINDERS 198
6.4 CAPACITANCE OF TWO CONCENTRIC SPHERES 200
6.5 TWO DIMENSIONAL PROBLEMS 202
6.6 TWO MEDIA FIELD PROBLEMS 210
6.7 ELECTROSTATIC THREE DIMENSIONAL FIELD PROBLEMS 216
PROBLEMS 226

CHAPTER 7: STATIC MAGNETIC FIELD

7.0 INTRODUCTION 228
7.1 ELECTRIC CURRENT 229
7.2 ELECTRIC CURRENT DENSITY DISTRIBUTIONS 234
7.3 CONTINUITY EQUATION 239
7.4 BIOT-SAVART LAW 242
7.5 CONTINUOUS LINE CURRENT DISTRIBUTION 248
7.6 CONTINUOUS SURFACE CURRENT DISTRIBUTION 256
7.7 MAGNETIC FIELD- CONTINUOUS VOLUME CURRENT DISTRIBUTION 264
7.8 SUMMARY 266
PROBLEMS 268

PAGE

CHAPTER 8: MAGNETIC FLUX DENSITY

8.0 INTRODUCTION 270

8.1 GAUSS'S LAW FOR MAGNETIC FIELD 273

8.2 DIVERGENCE OF MAGNETIC FIELD 275

8.3 AMPERE'S LAW 279

8.4 CURL OF MAGNETIC FIELD 289

8.5 SUMMARY 302

PROBLEMS 303

CHAPTER 9: MAGNETIC VECTOR POTENTIAL

9.0 INTRODUCTION 305

9.1 WORK DONE AND MAGNETIC SCALAR POTENTIAL 306

9.2 GRADIENT OF MAGNETIC SCALAR POTENTIAL 308

9.3 LAPLACE EQUATION FOR MAGNETIC SCALAR POTENTIAL 310

9.4 VECTOR MAGNETIC POTENTIAL 313

9.5 SOLUTION FOR MAGNETIC VECTOR POTENTIAL 316

9.6 MAGNETIC VECTOR POTENTIAL- LINE CURRENT DISTRIBUTION 326

9.7 MAGNETIC VECTOR POTENTIAL- SURFACE CURRENT DISTRIBUTION 327

9.8 MAGNETIC VECTOR POTENTIAL- VOLUME CURRENT DISTRIBUTION 329

9.9 SUMMARY 331

PROBLEMS 332

CHAPTER 10: MAGNETIC MATERIAL MEDIUM

10.0 INTRODUCTION 334

10.1 FORCE ON CONDUCTOR CARRYING CURRENT 335

10.2 FORCE BETWEEN TWO CURRENT LOOPS 338

10.3 MAGNETIC POLARIZATION 341

10.4 BIOT-SAVART'S LAW IN MAGNETIC MEDIUM 349

10.5 MAGNETIC FIELD LINES AND DENSITY 354

10.6 VECTOR POTENTIAL FOR MAGNETIC MEDIUM 356

10.7 BOUNDARY CONDITIONS 359

PAGE

10.8 SUMMARY 365

PROBLEMS 367

CHAPTER 11: SOLUTION TO MAGNETOSTATIC FIELD PROBLEMS

11.0 INTRODUCTION 369

11.1 INFINITELY LARGE PARALLEL PLATES 372

11.2 INFINITELY LONG COAXIAL CYLINDERS 374

11.3 MAGNETIC FIELD DUE TO CIRCULAR LOOP 375

11.4 IMAGE PRINCIPLE 378

PROBLEMS 382

CHAPTER 12: MAXWELL'S EQUATIONS IN TIME DOMAIN

12.0 INTRODUCTION 384

12.1 CHARGE DENSITY DISTRIBUTIONS 385

12.2 CONTINUITY EQUATION 392

12.3 FARADAY'S LAW 394

12.4 MAXWELL'S FIRST EQUATION 398

12.5 MAXWELL'S SECOND EQUATION 403

12.6 SUMMARY OF ELECTROMAGNETIC FIELD EQUATIONS 407

12.7 ELECTROMAGNETIC BOUNDARY CONDITIONS 411

12.8 POWER AND ENERGY STORED 423

12.9 SUMMARY 427

PROBLEMS 428

CHAPTER 13: TIME DOMAIN SOLUTION

13.0 INTRODUCTION 430

13.1 WAVE EQUATION 431

13.2 SOLUTION TO WAVE EQUATION 437

13.3 VECTOR PLANE WAVE FIELDS 446

13.4 PROPERTIES OF PLANE WAVE FIELDS 449

13.5 ONE DIMENSIONAL FIELD PROBLEM 455

PAGE

13.6 ELECTROMAGNETIC FIELDS IN A LOSSY MEDIUM 468
13.7 SUMMARY 481
PROBLEMS 482

CHAPTER 14: MAXWELL'S EQUATIONS IN FREQUENCY DOMAIN

14.0 INTRODUCTION 484
14.1 FOURIER TRANSFORM DOMAIN 485
14.2 SOURCES IN FREQUENCY DOMAIN 489
14.3 MAXWELL'S FIRST EQUATION 495
14.4 MAXWELL'S SECOND EQUATION 499
14.5 SUMMARY OF ELECTROMAGNETIC FIELD EQUATIONS 502
14.6 ELECTROMAGNETIC BOUNDARY CONDITIONS 505
14.7 POWER AND ENERGY STORED 509
14.8 SUMMARY 515
PROBLEMS 516

CHAPTER 15: FREQUENCY DOMAIN SOLUTION

15.0 INTRODUCTION 518
15.1 HELMHOLTZ EQUATION 519
15.2 SOLUTION TO HELMHOLTZ EQUATION 525
15.3 VECTOR PLANE WAVE FIELDS 530
15.4 ONE DIMENSIONAL FIELD PROBLEM 535
15.5 PROPAGATION CONSTANT 544
15.6 PLANE WAVES IN DIFFERENT MEDIA 546
15.7 DIELECTRIC BOUNDARY - NORMAL INCIDENCE 561
15.8 SUMMARY 570
PROBLEMS 572

CHAPTER 16: ANTENNAS AND RADIATION

16.0 INTRODUCTION 574
16.1 ELECTROMAGNETIC POTENTIALS 575

PAGE

16.2 SOLUTION FOR POTENTIALS 582

16.3 ELECTRIC DIPOLE FIELDS 592

16.4 MULTIPLE POINT SOURCES 598

16.5 SUMMARY 600

PROBLEMS 601

CHAPTER 17: WAVEGUIDES AND TRANSMISSION LINES

17.0 INTRODUCTION 603

17.1 WAVEGUIDE FIELDS 604

17.2 TRANSMISSION LINE 613

17.3 CIRCUIT MODEL 624

17.4 PROPAGATION CONSTANT 630

17.5 TRANSMISSION LINE PROBLEMS 632

17.6 TRANSVERSE ELECTRIC FIELDS 639

17.7 RECTANGULAR WAVEGUIDE - TE CASE 642

17.8 SUMMARY 649

PROBLEMS 650

INDEX 652

BIBLIOGRAPHY 658