# PURBANCHAL UNIVERSITY

Biratangar, Nepal

## B.E. (Electrical)
## Syllabus (2070)

**Year: II** **Semester: IV**

| S. No. | Course Code | Course Description | Credits | Lecture | Tutorial | Laboratory | Total |
|---|---|---|---|---|---|---|---|
| 1. | BEG235EC | Electromagnetics | 3 | 3 | 1 | 3/2 | 5.5 |
| 2. | BEG204SH | Applied Mathematics | 3 | 3 | 2 | - | 5 |
| 3. | BEG370CO | Numerical Methods | 4 | 3 | 1 | 3 | 7 |
| 4. | BEG225EL | Electrical Machine I | 3 | 3 | 1 | 3/2 | 5.5 |
| 5. | BEG226EL | Power System Analysis I | 3 | 3 | 1 | - | 4 |
| 6. | BEG227EL | Instrumentation I | 3 | 3 | - | 3/2 | 4.5 |
| | | Total | 19 | 18 | 6 | 7.5 | 31.5 |

# ELECTROMAGNETICS
## BEG235EC

**Year: II** **Semester: IV**

| Teaching Schedule Hours/Week | | | Examination Schedule | | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | **Tutorial** | **Practical** | **Internal Assessment** | | **Final** | | **Total** |
| **3** | **1** | **3/2** | **Theory** | **Practical** | **Theory** | **Practical** | **125** |
| | | | **20** | **25** | **80** | **-** | |

**Course Objectives :** The objective of this course is to provide the knowledge to understand the fundamental laws of static and dynamic electric and magnetic field and apply electromagnetic field and wave theory in the generation ,transmission and measurement techniques.

1. **Introduction** **[3 hrs]**
   1.1. Scalars and Vectors
   1.2. Vector Algebra
   1.3.Coordinate System
   1.4.Scalar and Vector Operations in Different Coordinate Systems

2. **Coulomb's Law and Electric Field Intensity** **[3 hrs]**
   2.1. Coulomb's Law
   2.2. Electric Field Intensity
   2.3. Field due to Point Charge and Continuous Charge Distribution
   2.4. Field of a Line Charge and Sheet of Charge

3. **Electric Flux Density and Gauss's Law** **[ 2hrs]**
   3.1. Electric Flux Density
   3.2.Gauss's Law Integral Form
   3.3. Application of Gauss's Law
   3.4.Boundary Condition at a Conductor Surface

4. **Divergence** **[2 hrs]**
   4.1. Concept of Divergence
   4.2. Maxwell's First Equation and Applications
   4.3. Vector Operator
   4.4. Divergence Theorem and Applications

5. **Energy and Potential** **[3 hrs]**
   5.1. Electric Energy
   5.2. Potential and Potential Difference
   5.3. Potential Field of a Point Charge and System of Charges

5.4. Potential Gradient
5.5. Electric Intensity as the Negative Gradient of a Scalar Potential
5.6. Conservative Fields
5.7. Electric Energy Density

**6. Electrostatic Field in Material Media** **[2 hrs]**
6.1. Polarization
6.2. Free and Bound Charge Densities
6.3. Relative Permittivity
6.4. Capacitance Calculations

**7. Boundary Value Problems in Electrostatic** **[5 hrs]**
7.1. Laplace's and Poisson's Equations
7.2. Uniqueness Theorem
7.3. One – dimensional and Two – dimensional Boundary Value Problems
7.4. Relaxation Methods and Numerical Integration
7.5. Graphical Field Plotting

**8. Current and Current Density** **[2 hrs]**
8.1. Conservation of Charge
8.2. Continuity of Current
8.3. Point Form of Ohm's Law
8.4. Relaxation Time Constant

**9. Magnetostatics** **[3 hrs]**
9.1. Biot-Savart's Law
9.2. Magnetic Intensity and Magnetic Induction
9.3. Ampere's Circuital Law
9.4. Applications

**10. Curl** **[3 hrs]**
10.1. Introduction
10.2. Stroke's Theorem
10.3. Magnetic Flux and Magnetic Flux Density
10.4. Ampere's Law in Point Form
10.5. Scalar and Vector Magnetic Potentials
10.6. Derivations of Steady Magnetic Field Laws
10.7. Boundary Value Problems

**11. Magnetic Force and Material** **[1 hrs]**

11.1. Magnetic Force
11.2. Magnetization and Permeability
11.3. Magnetic Boundary Conditions
11.4. Magnetic Circuits

**12. Time Varying Fields and Maxwell’s Equations [3 hrs]**

12.1. Faraday’s Law
12.2. Inadequacy of Ampere’s Law with Direct Current
12.3. Conflict with Continuity Equation
12.4. Displacement Current
12.5. Maxwell’s Equation for Time Varying Field
12.6. Retarded Potential

**13. Wave Equations [8 hrs]**

13.1. Wave Motion in Free Space, Perfect Dielectric and Lossy Medium
13.2. Wave Impedance, Skin Effect, AC Resistance
13.3. Poynting Vector
13.4. Reflection and Refraction of Uniform Plane Wave
13.5. Reflection and Transmission Coefficient
13.6. Standing Wave Ratio
13.7. Impedance Matching
13.8. Wave Guides

**14. Transmission Lines [4 hrs]**

14.1 Types of transmission mediums
14.2 Characteristic impedance
14.3 Power and Signal transmission capability of lines
14.4 Field and lumped circuit equivalence
14.5 Travelling and standing waves, reflection, transmission coefficients, impedance Matching
14.6 Short and long lines
14.7 Graphical solutions of the transmission lines

**15. Introduction to Microwaves [1 hr]**

**Laboratory :**

Six laboratory exercise to demonstrate the concept of electromagnetic using simulation software, MATLAB

**References :**

1. W.H Hyat “Engineering Electromagnetic”. Tata McGraw-Hill Book Company, New Delhi
2. J.D. Kraus and K.R.Carver “Electromagnetics”

**APPLIED MATHEMATICS**
**BEG204SH**

**Year: II** **Semester: IV**

| **Teaching schedule hours /week** | | | **Examination scheme** | | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | **Tutorial** | **Practical** | **Internal assessment** | | **Final** | | |
| **3** | **2** | **-** | **Theory** | **Practical** | **Theory** | **Practical** | |
| | | | **20** | **-** | **80** | **-** | |

**Objective:-** The aim of this course is to expose students to theory of complex variables, Fourier and Z transforms applied to signal processing. The course also impacts the fundamental knowledge on wave and diffusions equations with coordinate systems

1. **Complex Variables** **(12 hrs)**
   - 1.1 Function of complex variables
   - 1.2 Taylor series, Laurent series
   - 1.3 Singularities , zeros and poles
   - 1.4 Complex integration
   - 1.5 Residues

2. **Z-Transforms** **(10 hrs)**
   - 2.1 Introduction
   - 2.2 One sided and two sided Z-transforms
   - 2.3 Linear time invariant system, response to the unit spike
   - 2.4 Properties of Z-transform
   - 2.5 Region of convergence, relation to casualty
   - 2.6 Inverse Z – Transform
   - 2.7 Parseval’s Theroem
   - 2.8 Difference equation and its solution, representation of system transfer functions in Z- domain

3. **Fourier Integral and Transform** **(7 hrs)**
   - 3.1 The fourier integral, the inverse fourier integral
   - 3.2 Fourier sine and cosine transform
   - 3.3 Forward and inverse fourier transform
   - 3.4 Magnitude , energy and phase equation

4. **Partial Differential Equation** **(10 hrs)**
   - 4.1 Wave equation
   - 4.2 Diffusion equation
   - 4.3 Laplace equation in two and three dimensions
   - 4.4 Polar , cylindrical and spherical form

5. **Linear Programming** **(6 hrs)**
   - 5.1 Introduction of graphical method

5.2 Simplex method with constructing duality
5.3 Canonical forms of solution
5.4 Optimal values.

References:

1. E. Kreyszig, : “Advanced Engineering mathematics”
2. J. G. Proakis and D G manolakis, “Digital Signal processing”, Prentice Hall of India

**Mark distribution**

| Chapters | Hours | Total questons |
|---|---|---|
| 1 | 12 | 2 |
| 2 | 10 | 2 |
| 3 | 7 | 1 |
| 4 | 10 | 2 |
| 5 | 6 | 1 |
| Total | 45 | 8 |

- Attempt Any six questions out of eight (Question No one is compulsory with 15 marks )
- All other questions carry equal marks 13

# NUMERICAL METHODS
**BEG370CO**

**Year: II** **Semester:** IV

| Teaching Schedule Hours/Week | | | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | **Tutorial** | **Practical** | **Internal Assessment** | | **Final** | | **Total** |
| **3** | **1** | **3** | **Theory** | **Practical*** | **Theory**** | **Practical** | 150 |
| | | | 20 | 50 | 80 | - | |

*** Continuous**
**** Duration:** 3 hours

**Course Objective:** To solve the engineering problems by using the theory of numerical computational procedures.

1. **Introduction** **(2 hours)**
    1.1. Introduction to Numerical Method
    1.2. Needs of Numerical Method
    1.3. Number and their accuracy
    1.4. Errors (Absolute, Relative, rounding off error, truncation error, general error formula)
    1.5. Convergence

2. **System of non-linear equations** **(8 hours)**
    2.1. Introduction
    2.2. Graphical Method
    2.3. The iteration methods
    2.4. The bisection method
    2.5. Newton Raphson Method
    2.6. Secant Method
    2.7. Fixed point iteration
    2.8. Zeros of polynomials by horner's method

3. **Interpolation** **(10 hours)**
    3.1. Introduction
    3.2. Polynomial forms
    3.3. Linear interpolation
    3.4. Lagrange Interpolation polynomial
    3.5. Spline Interpolation
    3.6. Chebyshev Interpolation Polynomial
    3.7. Least squares method of fitting continuous and discrete data or function

**4 Numerical differentiation and integration** **(5 hours)**

4.2 Introduction

4.3 Numerical differentiation

4.4 Numerical integration

4.5 Numerical double integration

**5 Matrices and linear systems of equations** **(10 hours)**

5.2 Introduction

5.3 Review of the properties of matrices

5.4 Solution of linear systems-direct methods

5.5 Solution of linear systems-iterative methods

5.6 The eigen value problem

5.7 Singular Value decomposition

6 **Numerical Solution of ordinary differential equations** **(7 hours)**

6.1 Introduction

6.2 Euler's method for solving ordinary differential equation of first order

6.3 Runga-Kutta methods

6.4 Predictor- Corrector methods

6.5 Simultaneous and higher order equations

6.6 Initial value problems

6.7 Boundary value problems

**7 Numerical Solution of partial differential equations** **(3 hours)**

7.1 Introduction

7.2 Finite-difference approximations to derivates

7.3 Laplace's Equation

7.4 Parabolic Equations

7.5 Iterative methods for the solution of equations

7.6 Hyperbolic equation

**Laboratory:**

There shall be 12 laboratory exercises using high level programming language

**References:**


1. Computer Oriented Numerical Methods, V. Rajaraman
2. Introductory methods of Numerical analysis, S.S. Sastry
3. An Introduction to numerical computations, S. Yakowitz and F. Szidarovszky

# ELECTRICAL MACHINES I

**BEG225EL**

**Year: II** **Semester: IV**

| Teaching Schedule Hours/Week | | | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | **Tutorial** | **Practical** | **Internal Assessment** | | **Final** | | **Total** |
| **3** | **1** | **3/2** | **Theory** | **Practical*** | **Theory**** | **Practical** | 125 |
| | | | 20 | 25 | 80 | - | |

**Course Objectives:**

1. To apply the principles of electric and magnetic circuits for electric and magnetic circuits for electromechanical energy conversion.
2. To impart knowledge on constructional details, operating principle and performance of Transformer, DC Machine and 3-phase induction motor.
3. To understand the application of electrical machines.

**1. Introduction** **(6 hrs)**

Magnetic circuits and Ampere's law, Types of magnetic circuit, ferromagnetic materials, Hysteresis curve, Hysteresis & Eddy current losses, Faraday's Laws of electromagnetic induction, Self & mutual inductances, Magnetically coupled circuits, Force on current carrying conductor.

**2. Transformers** **(12 hrs)**

Construction Details, working principle and derivation of EMF equation, Ideal transformer, Transformer on No-load, Transformer on load, Real transformer & equivalent circuit, Looses in transformer, open circuit & shot circuit tests, Efficiency & voltage regulation, Auto-transformer, Three phase transformer, Parallel operation of transformer, Load sharing, Auto-transformer, r, Instrument transformer (potential & current transformers), Three phase transformer connection(Y/Y,Y/Δ,Δ/Y, Δ/Δ and V/V (or open Δ) connections.

**3. DC Generator** **(8 hrs)**

Construction & working principle of dc generator, EME l, Method of excitation, Armature reaction & commutation, Compensating windings, Basic performance equations for the dc machines: magnetization curve & effect of armature mmf on machine calculations: Characteristics of DC Generators (Separately excited, shunt, series & compound),Losses in DC generators, Efficiency and Voltage regulation.

**4. DC Motor** **(8 hrs)**

Construction and working principle of DC Motor, Characteristics of DC motors (shunt, series & compound): DC motor starting: 3 point and 4 point starter: Speed control of DC motors by varying the armature-circuit resistance, by varying the field flux & by varying the armature terminal voltage: Losses and Efficiency of DC motor, DC motor applications, Reversing of DC Motors.

**5. Three-Phase Induction Machines (11 hrs)**

Three Phase Induction Motor: Constructional Details and Types, Operating Principle, Rotating Magnetic Field, Synchronous Speed, Slip, Induced EMF, Rotor Current and its frequency, Torque Equation, Torque-Slip characteristics, Effect of rotor resistance on Torque-Slip characteristics, Testing of Induction Motor, Losses, Power stages and Efficiency, Starting Methods, Speed Control Methods, Double Cage Induction Motor, Three Phase Induction Generator: Working Principle, voltage build up in an Induction Generator, Power Stages, Isolated and Grid connected mode

**Practicals:**

1. Magnetic Circuits
    - To draw B-H curve for two different sample of Iron Core
    - Compare their relative permeabilities
2. Two Winding Transformers
    - To perform turn ratio test
    - To perform open circuit (OC) and short circuit (SC) test to determine equivalent circuit parameter of a transformer and hence to determine the regulation and efficiency at full load
    - To examine exciting current harmonics
3. DC Generator
    - To draw open circuit characteristic (OCC) of a DC shunt generator and to calculate: (a) Maximum voltage built up (a) Critical resistance and critical speed of the machine
    - To draw load characteristic of shunt generator
4. DC Motor
    - Speed control of DC Shunt motor by (a) armature control method (b) field control method
    - To observe the effect of increasing load on DC shunt motor’s speed, armature current, and field current.
5. 3-phase Induction Machines
    - To draw torque-speed characteristics and to observe the effect of rotor resistance on torque-speed characteristics
    - To perform no load and blocked rotor test to evaluate equivalent circuit parameters

**References:**

1. I.J. Nagrath & D.P. Kothari," Electrical Machines", Tata McGraw Hill
2. S. K. Bhattacharya, "Electrical Machines", Tata McGraw Hill
3. Husain Ashfaq , "Electrical Machines", Dhanpat Rai & Sons
4. A.E. Fitzgerald, C.Kingsley Jr and Stephen D. Umans,"Electric Machinery", Tata McGraw Hill
5. P. S. Bhimbra, "Electrical Machines"' Khanna Publishers
6. Irving L. Kosow, "Electric Machine and Transformers", Prentice Hall of India.
7. M.G. Say, "The Performance and Design of AC machines", Pit man & Sons.

# POWER SYSTREM ANALYSIS I

**BEG226EL**

## Year: II Semester: IV

| Teaching Schedule Hours/Week | | | Examination Schedule | | | | |
|---|---|---|---|---|---|---|---|
| Theory | Tutorial | Practical | Internal Assessment | | Final | | Total |
| | | | Theory | Practical | Theory | Practical | |
| 3 | 1 | | 20 | - | 80 | - | 100 |

**Course Objective:**

The course aim to deliver the basic principle and fundamental analysis techniques for generation, transmission and distribution components of a power system as a first course in power system

1. General Background (6 hours)
   - 1.1 Growth of electric power system, energy production
   - 1.2 Generation, Transmission and Distribution Components, Load studies
   - 1.3 Energy Sources; hydro, thermal, Nuclear etc.
   - 1.4 Basic introduction to renewable energy; Photovoltaic, wind, geothermal etc
   - 1.5 Major electrical components in power station; alternators, transformers, bus bars, voltage regulators, switch and isolators, metering and control panels
   - 1.6 Infinite bus concept
   - 1.7 Voltage levels, AC Vs DC Transmission
   - 1.8 Single phase and three phase power delivery
2. Overhead & Underground Transmission ( 8 hours)
   - 2.1 Line supports, spacing between conductors
   - 2.2 Transmission line conductor materials
   - 2.3 Stranded and bundled conductors
   - 2.4 Overhead line insulators, its types
   - 2.5 Voltage distribution along string of suspension insulators, string efficiency
   - 2.6 Classification, construction of underground cables, insulation resistance
   - 2.7 Dielectric stress in single core/multi core cables
   - 2.8 Cable faults and location of faults
3. Computational Technique (8 hours)
   - 3.1 Single phase representation of three phase system
   - 3.2 Impedance and reactance diagram
   - 3.3 Single line diagram
   - 3.4 Complex powers
   - 3.5 Direction of power flow
   - 3.6 Per unit system; advantage and applications
4. Line parameter calculations (10 hours)

4.1 Inductance, resistance and capacitance of a line
4.2 Inductance of line due to internal & external flux linkages
4.3 Skin & proximity effect
4.4 Inductance of single phase two wire line, stranded & bundled conductor consideration, concept of G.M.R and G. M.D, inductance of 3 phase line; equilateral and unsymmetrical spacing
4.5 Transposition, inductance of double circuit 3 phase lines
4.6 Concept of G.M.R and G. M.D for capacitance calculations
4.7 Capacitance calculations of single phase two wire line, stranded & bundled conductor consideration, capacitance of 3 phase line; equilateral and unsymmetrical spacing, double circuit
4.8 Earth effect in capacitance of a line

5. Transmission line modeling (5 hours)
5.1 Classification of a lines based on short, medium and long lines
5.2 Representation of 'Tee' and 'Pi' of medium lines; calculation of ABCD parameters
5.3 Distributed Parameter model of Long lines; calculation of ABCD parameters
5.4 Equivalent 'Tee' and 'Pi' of long lines

6. Performance Analysis (8 hours)
6.1 Sending and receiving end quantities analysis
6.2 Voltage regulation & efficiency calculation of transmission lines
6.3 Transmission line as source and sink of reactive power
6.4 Real and reactive power flow through lines
6.5 Surge impedance loading
6.6 High capacitance effect of long lines
6.7 Reactive compensation of transmission lines

**References:**


1. Power System Analysis by W.D. Stevension, Tata McGraw Hill Publications
2. Modern Power system analysis by I.J Nagrath and D.P Kothari, Tata McGraw Hill Publications
3. Power System Analysis and Design by B.R. Gupta
4. Electric power Generation, Transmission & Distribution by S.N. Singh, Prentice Hall

# INSTRUMENTATION I

## BEG227EL

**Year: II** **Semester: II**

| Teaching Schedule Hours/Week | | | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|
| **Theory** | **Tutorial** | **Practical** | **Internal Assessment** | | **Final** | | **Total** |
| **3** | **-** | **3/2** | **Theory** | **Practical*** | **Theory**** | **Practical** | 125 |
| | | | 20 | 25 | 80 | - | |

**Course Objectives:** To provide fundamental knowledge of instrumentation and measurements.

1. **Introduction:** **(4 hours)**
   1.1. Instrumentation and Components of instrumentation
   1.2. Transducting, Signal Conditioning and Signal Transmission
   1.3. Input and Output device
   1.4. Analog and Digital System

**2. Measurements:** **(8 hours)**
   2.1. Units and standards of measurements
   2.2. Measuring instruments: Performance parameters, Dynamic parameter
   2.3. Inductance and capacitance bridges
   2.4. Error in measurement and error type
   2.5. Measurement of voltage & current (moving coil & moving iron instruments)
   2.6. Measurement of low, high & medium resistances
   2.7. AC bridge & measurement of inductance and capacitance

3. **Variables and Transducers**: **(6 hours)**
   3.1. Physical variables and their types (Electrical, Mechanical, Process, Bio-physical variable)
   3.2. Types, principle of operation, input and output characteristics and applications of transducers (resistive, capacitive, inductive, voltage and currents)
   3.3. Calibrations and error in transducers

4. **Signal Conditioning and Processing**: **(8 hours)**
   4.1. Importance of signal conditioning and processing
   4.2. Signal amplification and Filtering
   4.3. Instrumentation amplifier: Op-Amp in instrumentation
   4.4. Interference signals and their elimination: shielding and grounding
   4.5. Sample data system, sample and hold circuit
   4.6. Components of data acquisition system

**5. Analog - Digital and Digital - Analog Conversion** **(9 Hours)**
   5.1 Analog signal and digital signal

5.2 Digital to analog convertors - weighted resistor type, R-2R ladder type, DAC Errors
5.3 Analog to digital convertors - successive approximation type, ramp type, dual ramp type, flash type, ADC errors

**6. Electrical equipments (10 Hours)**

6.1 Wattmeter: Types, Working principle
6.2 Energy meter: Types, Working Principle
6.3 Frequency meter: Types, Working Principle
6.4 Power factor meter

**Laboratory:**

1. Measurement of physical variables using various bridges.
2. Conversion of physical variables into electrical signal.
3. Signal conditioning (amplification and filtering).
4. Error measurements in instrumentation system.
5. Observation of interference in instrumentation and their remedy.
6. Conversion of analog signal into digital and digital into analog signal.

**References:**


1. A.D. Helfrick and W.D. Cooper, "*Modern Electronic Instrumentation and Measurement Techniques*", Prentice Hall of India 1996.
2. S. Wolf and R.F.M. Smith, "*Student Reference Manual for Electronic Instrumentation Laboratories*", Prentice-Hall of India 1996
3. A. K. Sawhney, "*A Course in Electronic Measurements and Instrum*entation", Dhanapat Rai and Sons, India, 1998
4. C.S. Rangan, G.R.Sarma, and V.S.V. Main, "*Instrumentation: Devices and Systems*", Tata McGraw Hill, India, 1992
5. D.M. Considine, "*Process Instruments and Controls Handbooks*", McGraw Hill 1985.