Course Details for UG Curriculum and Syllabus of Bachelor of Electrical Engineering Program

Electrical Engineering Department

Jadavpur University

Second Year First Semester

Course code	**EE/PC/B/T/221**
Category	Program Core
Course title	Signals & Systems
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PC/B/T/221 : Signals & Systems	L	T
General concept of Systems: Classification. Differential equation of Systems. Definition of Linear Time invariant (LTI) Systems. Laplace Transform (LT) methods for solving linear differential equations with constant coefficients.	2	1
Concept of transfer function. Open-loop and closed-loop systems. Poles and zeros. Concept of frequency response. Bode Plot.	3	1
Time response of First and Second order systems. Time-domain specifications. Concept of damping ratio and natural frequency. Effect of addition of poles and zeros.	3	1
Modeling of Dynamic Systems: Mechanical systems (including rotary systems, gears, articulated systems, Electromechanical systems, DC motors, moving coil speakers, ballistic galvanometers, Thermal systems (first order and second order models), Electric circuit analogues.	3	0
Modeling of LTI systems using operational amplifiers. Simulation of differential equations with operational amplifiers. Amplitude scaling and Time Scaling.	2	1
State variable representation of systems: Normalization of linear equations. Concept of state variables. Representation in standard forms. Concept of state trajectories.	2	1
Classification of signals: Deterministic & Random signals, Continuous-time (CT) & Discrete-time (DT) signals, Power & Energy signals, Causal & Non-causal signals.	1	0
Time-domain operations on CT signals: Addition, multiplication, time-reversal, time-translation and time-scaling. Mathematical descriptions of deterministic CT signals.	1	1
Singularity functions: Impulse (Dirac Delta) function and its properties, Step function, Ramp and Parabola. Decomposition of simple aperiodic waveforms in terms of singularity-function components.	3	1
Convolution Integral: Analytical &Graphical convolution. Properties of convolution. Convolution representation of linear time-invariant (LTI) systems.	2	1
Fourier Series representation of CT periodic signals: Review of Trigonometric Fourier Series. Exponential Fourier Series and Line- Spectra. Properties of Fourier	2	1

Series. Parseval's formula for periodic signals.		
CT Fourier Transform & Integral: Generalized Fourier Transform. Properties of Fourier Transform. Parseval's theorem for aperiodic signals. Energy Spectral Density. Power Spectral Density of periodic signals. Concept of autocorrelation functions for deterministic signals.	3	1
Frequency response of LTI systems: Definitions, significance, frequency responses of first-order & second-order systems. Concept of causality and stability of LTI systems.	2	1

Course code	**EE/PC/B/T/212**
Category	Program Core
Course title	Circuit Theory
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PC/B/T/212: Circuit Theory	L	T
Laplace Transform-Transform of standard periodic and non-periodic waveforms.Circuit elements and their transformed equivalents. Concept of natural frequency and damping.	4	2
Transient and steady state response of RL, RC, LC and RLC circuits in transient with or without stored energy – solutions in *t*&*s* domains. Sketching transient response, determination of peak values.	6	2
Two Port networks, Series, parallel and cascade connections of two port networks. Elements of realisability and synthesis of one port network.	8	2
Independent and dependent sources and equivalence of sources, treatment of mutual couplings.	3	1
Network Theorems – Reciprocity theorem, Compensation theorem, Substitution theorem, Tellegen's theorem and Millman's theorem for voltage and current sources.	6	2
Loop and node variable analysis of transformed circuits. Applications of network theorems in steady state and transient domains.	3	1
Graph of network: Concept of tree branch, tree link, tie set and cut set. Various incidence matrices and their properties, loop currents and node-pair potentials, formulation of equilibrium equations on the loop and node basis.	6	2
Nonlinear circuit analysis – Nonlinear resistances and inductances, series and parallel combination of linear and nonlinear resistances and inductances, Application of graphical techniques.	3	1

Reference Books:

1	Network Analysis: M. E. Van Valkenburg, Prentice Hall, 3rd Edition.
2	Engineering Circuit Analysis: W. H. Hayt, J. E. Kenmerly, S. M. Durbin, TMH, 6th Edition, 2002.
3	Network and Systems: Ashfaq Husain, Khanna Book Publisher, 2000.
4	Network and Systems: D. Roychowdhury, New Age International , 2001.
5	Modern Network Analysis: F. M. Reza & S. Seely, McGraw Hill.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Apply** Laplace Theorems to solve network problems. (K3)
CO2	**Identify** and **solve** electrical circuits as two port networks. (K2)
CO3	**Solve** transient and steady state response of RL, RC, LC and RLC circuits. (K3)
CO4	**Solve** electrical networks having both dependent and independent sources using mesh and nodal analysis methods. (K3)
CO5	**Construct** the equivalent representation of electrical networks using different network theorems. (K3)
CO6	**Associate** graph theoretic technique with the representation of electrical circuits. (K2)
CO7	**Explain** the effects of the presence of nonlinear elements in electrical network with the help of graphical techniques. (K2)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Circuit Theory	**CO1**	**3**	**2**	**1**									
	CO2	**2**	**3**	**2**	**1**								
	CO3	**2**	**3**	**2**									
	CO4	**3**	**2**	**2**	**1**								
	CO5	**2**	**3**	**2**									
	CO6	**2**	**3**	**2**	**1**								
	CO7	**3**	**2**	**2**	**1**								

Course code	**EE/ES/B/T/213**
Category	Engineering Science
Course title	Electrical Engineering Materials
Scheme and Credits	L-T-P: 3-0-0; Credits: 3.0;
Pre-requisites (if any)	

EE/ES/B/T/213: Electrical Engineering Materials	L	T
Atomic structure: Rutherford's Model and Bohr's Model related to simple Hydrogen atom; Nuclear binding energy and mass defect.	2	0
Wave nature of matter: Wave mechanical theory of atomic structure; Energy states.	2	0
Atomic bonding: Stable interatomic distance; Ionic, covalent, metallic and Van der Waals Bonding.	2	0
Crystal Structures: Unit cells; FCC, BCC and diamond structures; crystal defects.	1	0
Electron energy levels: Band theory of solids; Conductors, Insulators and Semiconductors.	1	0
Thermal properties of insulating materials	1	0
Electrical properties of insulating materials: Volume and surface resistivity, dielectric constant, dielectric dissipation factor and dielectric strength.	2	0
Polarization of dielectrics: Non-polar and polar dielectrics; Electronic, relaxation, ionic and dipole polarization; Classification of dielectrics by polarization mechanism; Dielectric polarization and permittivity.	2	0
Gaseous dielectrics: Properties of gases, breakdown phenomena.	2	0
Liquid dielectrics: Natural and synthetic dielectrics; Dielectric properties of liquids.	1	0
Solid insulating materials: Natural and synthetic resins; elastomers; fibrous materials; ceramic materials; mica and micanites.	2	0
Varnishes and compounds	1	0
Composite insulation: Oil-paper insulation and impregnating process	1	0
Conductors: Electrical conductivity of metals, Lorentz theory, free electron theory, electron scattering.	4	0
Intrinsic materials and alloys. Resistivities of conductors including alloys;	1	0
High resistivity conducting materials and their applications, contact materials..	2	0
Magnetic Materials: Atomic interpretation of ferromagnetic materials,	2	0
Atomic exchange force, crystallographic forces	1	0
magnetic anisotropy, magnetostriction, Curie-Weiss law, Curie law, Curie temperature of ferromagnetic materials,	2	0
Soft magnetic material, CRGO, Ni-Fe alloy and applications	2	0
Hard magnetic materials Alnico, Alcomax and application.	2	0
Ferrite-ferromagnetic materials and their applications, Piezo-electric materials.	2	0
Super Conductivity: Theory of super conductivities, critical field, critical current density, transition temperature; normal and superconductivity steps,	1	0

Types of super conductor, high temperature superconductor and applications.	1	0

Reference Books:

1	Electrical Engineering Material by A. J. Dekker
2	Electrical Engineering Material by B. M. Tareev
3	Dielectric Materials and applications by A. Von Hipple
4	Transistors : D. L. Croissette

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Recall** the atomic, molecular, physical, chemical, magnetic and electrical properties of different types of materials that are applicable in electrical engineering (K1).
CO2	**Classify** different engineering materials with respect to their application in electrical systems (K2).
CO3	**Calculate** the temperature dependence and endurance of a particular material in a system (K3).
CO4	**Apply** semiconducting,conducting and super conducting materials in appropriate engineering applications (K3).

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Electrical Engineering Materials	**CO1**	**3**					**1**	**2**					**1**
	CO2	**3**	**1**	**1**									**1**
	CO3	**1**	**2**	**3**									**1**
	CO4	**2**	**3**			**1**							**1**

Course code	**EE/PC/B/T/214**
Category	Program Core
Course title	Electrical Measurements & Measuring Instruments
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PC/B/T/214: Electrical Measurements & Measuring Instruments	L	T
Classification of electrical measuring instruments, general feature of indicating instruments: controlling, damping, balancing.	2	0
Galvanometer: dynamics, sensitivity, D'Arsonval galvanometer, Ballistic galvanometer, Vibration Galvanometer,	2	0
PMMC instrument, temperature compensation, rectifier type instrument,	1	0
Moving iron instrument, errors and compensations,	1	0
Electrodynamometer type instrument,	1	0
Extension of instrument range: shunt, multiplier,	1	1
Capacitive voltage divider power measurement for DC, single and three phase AC circuit low power factor wattmeter, wattmeter connections and errors,	2	1
Induction type energy meter: characteristics, errors and their compensation,	2	1
Current Transformer (C.T.), Potential Transformer (P.T.);	2	0
Classification of electrical measuring instruments, general feature of indicating instruments: controlling, damping, balancing.	2	1
Measurement of medium resistance using Wheatstone bridge, Series and Shunt type ohmmeter. Measurement of high resistance using Megohm bridge and Megger.	4	1
Measurement of phase / power factor using electrodynamometer type and moving iron type instrument. Measurement of frequency using electrical resonance type and ratio type instrument.	2	1
Kelvin double bridge, measurement of surface resistivity. Measurement of inductances and capacitances, measurement of incremental inductances, interbridge transformer, residuals, errors in bridges, detectors	2	1
DC potentiometer: Weston normal cell, Vernier type, Kelvin-Verley slide, dual range, applications, phantom loading,	2	1
Use of Ballistic Galvanometer in magnetic testing, ac magnetic testing: Lloyd-fisher square, Transducers:	2	1
RTD, thermistor, thermocouple, laws of thermocouple circuits, cold junction compensation, strain gauge.	2	1

Reference Books:

1	Electrical Measurement & Measuring Instrument: Golding & Widdis
2	Electrical Measurement: F. K. Harris
3	Electrical Measurement Analysis: Ernest Frank
4	Alternating Current Bridge Networks: Hague & Foord

5	Basic Electrical Measurement: M. B. Stout
6	Electrical Measurement: C. T. Baldwin
7	A Course in Electrical & Electronic Measurements & Instrumentation: A. K. Sawhney
8	Electronic & Electrical Measurements & Instrumentation: J. B. Gupta

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Describe** constructions of various electrical instruments. (K1)
CO2	**Discuss** theprinciple of operation of different types of electrical instruments. (K2)
CO3	**Solve** numerical problems on operations and applications electrical instruments and measuring circuits. (K3)
CO4	**Analyze** the importance and applications of various components of measuring circuits and instruments. (K4)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Electrical Measurements & Measuring Instruments	**CO1**	**3**	**1**										
	CO2	**3**	**2**	**1**									
	CO3	**3**	**2**										
	CO4	**2**	**3**	**2**	**1**								

Course code	**EE/PC/B/T/215**
Category	Program Core
Course title	Electrical Machines-I
Scheme and Credits	L-T-P: 2-1-0; Credits: 3.0;
Pre-requisites (if any)	

EE/PC/B/T/215: Electrical Machines-I	L	T
General introduction to electrical machines: Faraday's law of electromagnetic induction, Lenz's Law and Fleming's rules. Principle of operation of generators and motors. Space distribution of flux density and time variation of voltage. Flux wave in dc and ac machines. Magnetic curves and their relevance.	2	1
DC Machines: Detailed construction and operating principle. Materials used for DC machines. Function of commutator and brush system in Generator and Motor. Induced emf in DC machine. Separate, Shunt, Series and Compound excitation. Losses and efficiency. Voltage build up in DC shunt generator. DC motoring action. Torque developed in DC motor. Armature windings, Lap, Wave and Frogleg Windings, Equalisers and dummy coils. Armature reaction & its effects, mmf distribution, compensating windings, Interpoles, Laminated yoke construction. Commutation types, interface film.	4	2
DC Generators: Characteristics with different excitation systems, voltage regulation, parallel operation.	2	1
DC Motors: Characteristics and applications of Separate, Shunt, Series and Compound motors, methods of starting, speed control, equivalent circuit. Series-parallel operation of motors.	3	1
Testing of DC machines: Swinburne test, Hopkinson's test, Brake test. Tests specified as per standards.	2	1
Introduction to Permanent Magnet dc machines.	1	0
1-phase Transformers : Construction and basic principle of operation. Core type and shell type. Materials used for core, winding and insulation. Dry-type and oil cooled type. Natural and forced types of cooling. Tank and radiator construction, operation. Transformer oil. Transformer accessories, e.g. conservator, breather, Bucholtz relay, bushing, etc. EMF equation. Core loss, copper loss and Leakage reactances.	4	1
Harmonics in magnetizing current and magnetizing in-rush current.	1	0
Generalised derivation of electrical equivalent circuit from magnetic structure. Equivalent circuit referred to primary. Phasor diagram. Parallel operation. Effects of changes of frequency and voltage on transformer performance.	3	2
Power and Distribution Transformers, all-day efficiency.	1	1
Testing of transformers: Polarity of windings, OC and SC test, separation of losses, determination of equivalent circuit parameters. Regulation, efficiency.	2	1
Single phase auto-transformers, principle of operation, phasor diagram. Comparison of weight, copper loss equivalent reactance with 2-winding transformer.	2	1

Special Transformers: Current transformers, Pulse Transformers.	1	0

Reference Books:

1	AC Machines : Puchstein, Lloyd & Hunte
2	Electrical machines : P.K. Mukherjee & S. Chakravorti
3	Electrical Machinery : P. S. Bimbhra
4	Electrical Machinery : S. K. Sen
5	Performance and Design of Alternating Current Machines : M.G. Say
6	Principles of Alternating Current machinery : Lawrence
7	Performance and Design of Direct Current Machines : Clayton & Hancock.
8	Advanced Electrical Technology : H. Cotton
9	Electrical Machinery : A. E. Fitzgerald & C. Kingsley
10	Electric Machines : I. J. Nagrath & D. P. Kothari.

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Tutorial (D3)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	**Describe** the basic principles of operation of single phase transformer and rotating machines.
CO2	**Discuss** the constructions of single phase transformer and D.C. machine.
CO3	**Develop** equivalent circuits for single phase transformer.
CO4	**Develop** the voltage and torque equations considering armature reaction in a D. C. machine.
CO5	**Analyze** various performance characteristics of single phase transformer and D. C. machine.
CO6	**Solve** numerical problems related to various aspects of single phase transformer and D.C. machine.

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Electrical Machines-I	**CO1**	**3**	**2**	**1**				**1**					**1**
	CO2	**2**		**3**				**1**					**1**
	CO3	**2**	**2**	**3**				**1**					**1**
	CO4	**2**	**2**	**3**				**1**					**1**
	CO5	**1**	**2**	**3**				**1**					**1**
	CO6	**1**	**3**	**2**				**1**					**1**

Course code	**EE/ES/B/ME/T/216**
Category	Engineering Science
Course title	Engineering Thermodynamics & Heat Power
Scheme and Credits	L-T-P: 3-0-0; Credits: 3.0;
Pre-requisites (if any)	

EE/ES/B/ME/T/216: Engineering Thermodynamics & Heat Power	L	T
Introduction, Definitions: System, Surroundings, Immediate surroundings, Environment, Control volume, Isolated system Concept of Equilibrium: Mechanical, Chemical, Thermal The zeroth law of thermodynamics, concept of empirical temperature, Constant volume gas thermometer, Ideal gas temperature scale Thermodynamic equilibrium,. State, property – intensive, extensive, specific. Gibbs phase rule – statement. Problems	6	0
Heat and Work	1	0
Properties of pure substances. Ideal gases, substance those expand on freezing, substances those contract on freezing. P-v-T equilibrium surfaces. Property tables, charts. P-v, P-T and T-v plane diagrams Problems	4	0
Process- Quasistatic, reversible, cyclic The first law of thermodynamics: Joules' experiment, statement for cycle, corollary 1- statement for process, corollary 2 (Isolated system), corollary 3 (PMM I) Problems	3	0
Different thermodynamic processes – Isobaric, Isochoric, Isothermal, Adiabatic, Polytropic.	3	0
The second law of thermodynamics: Limitations of the first law of thermodynamics, Steadily operating systems – Heat engines, Heat pumps, Refrigerators. Kelvin Planck statement, Clausius statement, equivalence. Carnot theorem I, Carnot theorem II, Thermodynamic temperature scale, Carnot cycle, equivalence of thermodynamic temperature scale and Ideal gas temperature scale Clausius inequality, concept of entropy Problems	7	0
Control volume analysis, Steady State Steady Flow processes, Throttling process Problems	4	0
Gas power cycles: Air standard assumptions, air standard Otto cycle and Diesel cycle, Thermal efficiency, Mean effective pressure Problems	3	0
Vapour Power Cycle: Limitations of Carnot cycle, Rankine cycle, Reheat and Regeneration-concept	3	0

Problems		
Vapour Compression Refrigeration Cycle Problems	2	0
Basic laws of heat transfer, general heat conduction equation, boundary conditions, one dimensional heat conduction equation solutions, electrical analogy Problems	4	0

Reference Books:

1	Fundamentals of Thermodynamics: Richard E. Sonntag, Claus Borgnakke and Gordon J. Van Wylen
2	Heat and Thermodynamics: Mark W Zemansky and Richard H Dittman
3	Thermodynamics, Kinetic Theory, and Statistical Thermodynamics: Francis W. Sears, and Gerhard L. Salinger
4	URL for Thermodynamic Tables and Charts: https://eclass.upatras.gr/modules/document/file.php/MECH1206/CENGEL_%20PROPERTY%20Tables%206%20NEW-SIappendix1.pdf

Content Delivery Method

- Class room lecture (chalk and board) (D1)
- Visual presentation (D2)
- Active learning (D4)
- Blended learning (D5)
- Discussion (D7)

Course Outcomes:

The students of the course should be able to

CO1	Define thermodynamic system and related terminologies (K1)
CO2	Interpret the fundamental laws and principles (K2)
CO3	Apply laws and principles of thermodynamics for simple engineering systems (K3)
CO4	Understand conduction heat transfer applications and solve simple one dimensional problems (K2, K3)

CO-PO Mapping(3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Engineering Thermodyn -amics & Heat Power	**CO1**	**3**	**1**										
	CO2	**3**	**2**	**1**									
	CO3	**2**	**3**	**1**									
	CO4	**3**	**2**	**1**									

Course code	**EE/PC/B/S/211**
Category	Program Core
Course title	Electrical Engineering Laboratory - I
Scheme and Credits	L-T-P: 0-0-3; Credits: 1.5;
Pre-requisites (if any)	

EE/PC/B/S/211 : Electrical Engineering Laboratory - I	P
Characteristics of AC series and parallel Circuit	3
Measurement of Low Resistance by Kelvin Double Bridge	3
Study of constant current source	3
Study of Linear and Non-Linear Resistances	3
Coil connections & ratings of single phase transformer	3
Study of DC and AC Machines	3
Display analysis and recording of common waveforms	3
Study of d'Arsonval Galvanometer	3
Verification of Superposition theorem and Norton's theorem on trainer	3
Voltage and power characteristics of a ceiling fan	3
Introduction, arrear and assignment	9

Content Delivery Method

- Class room lectures (Chalk and Board) (D1)
- Active learning (D4)
- Blended/Hybrid learning (D5)
- Discussions (D7)
- Case Studies (D9)

Course Outcomes:

The students of the course should be able to

CO1	**Identify** the instruments required to perform the experiment on basics of electrical circuits (K1, S1)
CO2	**Select** the range/ratings of the instruments identified (K2, S1)
CO3	**Comprehend** the objective of the experiment and **Relate** that with the acquired theoretical knowledge (K3, S2)
CO4	**Develop** the circuit duly connecting selected instruments and other devices (K2, S2)
CO5	**Interpret** the data and prepare a detailed report. (K2, A2)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Electrical Engineering Laboratory - I	**CO1**	**3**	**2**	**1**						**2**			
	CO2	**1**	**3**	**2**						**2**			
	CO3	**1**	**3**	**2**						**2**			
	CO4	**1**	**2**	**3**						**2**			
	CO5	**1**	**1**	**2**	**3**				**1**	**2**		**1**	**1**

Course code	**EE/PC/B/ME/S/212**
Category	Program Core
Course title	Computer Aided Drafting
Scheme and Credits	L-T-P: 0-0-3; Credits: 1.5;
Pre-requisites (if any)	

EE/PC/B/S/212 : Computer Aided Drafting	P
Introduction to a computer aided drafting software, Basic commands of 2D drafting, Drafting assignment	9
Concept of Layer, Layout, Model space, Paper space, Viewport, Creation and use of template,Drafting assignment	11
Dimensioning, Blocks, Attributes, Accessing internal and external database files, Drafting assignments	11
Isometric drawing using iso-planes, Drafting assignment	8

Content Delivery Method

- Class room lectures (Chalk and Board) (D1)
- Visual Presentation (D2)
- Tutorial (D3)
- Demonstration (D8)

Course Outcomes:

The students of the course should be able to

CO1	**Identify** the basic 2D drafting tools (drawing and editing) and toolbars in drafting software. (K1, A1, S1)
CO2	**Interpret** the concept of layer, and of model space and paper space in conjunction with viewport. (K2, A2, S2)
CO3	**Describe** the concept of blocks; attributes etc. to better organize complicated drawings. (K2, A2, S2)
CO4	**Prepare** engineering drawing of simple machine components up to its paper printout with proper scale. (K3, A3, S3)
CO5	**Construct** isometric drawings for simple engineering components. (K3, A2, S2)

CO-PO Mapping (3 – Strong, 2 – Moderate and 1 – Weak)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Computer Aided Drafting	**CO1**	**3**	**2**	**1**						**2**			
	CO2	**1**	**3**	**2**						**2**			
	CO3	**1**	**3**	**2**						**2**			
	CO4	**1**	**2**	**3**						**2**			
	CO5	**1**	**1**	**2**	**3**				**1**	**2**		**1**	**1**