Advanced Fluid Mechanics

Sem-V

General Course Information:

Course Code: PCC-CVE301-T Course Credits: 3 Mode: Lecture (L) Type: Core Course Contact Hours: 3 hours (L) Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20marks, class performance measured through percentage of lecture attended (4 marks), assignments and quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Illustrate drag and lift coefficients	**L2(Understanding)**
CO2	Demonstrate flow profiles in channel transitions and analyze hydraulic transients	**L3(Applying)**
CO3	Analyze compressible flows of liquids and gases	**L4(Analyzing)**
CO4	Design the working proportions of hydraulic machines	**L5(Evaluating)**
CO5	Design channels	**L6(Creating)**

Course Contents

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UNIT-I

Laminar Flow: Navier Stoke's equation, Laminar flow between parallel plates, Couette flow, laminar flow through pipes-Hagen Poiseuille law, laminar flow around a sphere-Stokes'law.

Flow through pipes: Types of flows-Reynold's experiment, shear stress on turbulent flow, boundary layer in pipes-Establishment of flow, velocity distribution for turbulent flow in smooth and rough pipes, resistance to flow of fluid in smooth and rough pipes, Stanton and Moody's diagram. Darcy's weisbach equation, other energy losses in pipes, loss due to sudden expansion, hydraulic gradient and total energy lines, pipes in series and in parallel, equivalent pipe, branched pipe, pipe networks, Hardy Cross method, water hammer.

Unit-II

Drag and Lift: Types of drag, drag on a sphere, flat plate, cylinder and airfoil, development of lift on immersed bodies like circular cylinder and airfoil.

Open Channel Flow: Type of flow in open channels, geometric parameters of channel section, uniform flow, most economical section (rectangular and trapezoidal), specific energy and critical depth, momentum in open channel, specific force, critical flow in rectangular channel, applications of specific energy and discharge diagrams to channel transition, metering flumes, hydraulic jump in rectangular channel, surges in open channels, positive and negative surges, gradually varied flow equation and its integration, surface profiles.

Unit-III

Compressible flow: Basic relationship of thermodynamics continuity, momentum and energy equations, propagation of elastic waves due to compression of fluid, Mach number and its significance, subsonic and supersonic flows, propagation of elastic wave due to disturbance in fluid mach cone, stagnation pressure.

Unit-IV

Pumps and Turbines: Reciprocating pumps, their types, work done by single and double acting pumps. Centrifugal pumps, components and parts and working, types, heads of a pump-statics and manometric heads,. Force executed by fluid jet on stationary and moving flat vanes, Turbines-classifications of turbines based on head and specific speed, component and working of Pelton wheel and Francis turbines, cavitation and setting of turbines.

REFERENCE BOOKS:

1 Fluid Mechanics and Hydraulic Machines , Mahesh Kumar, Pearson Education, 2019

2 Hydraulics & Fluid Mechanics by P.N.Modi and S.M.Seth

2. Fluid Mechanics by R. K. Bansal

3. Flow in Open Channels by S.Subraminayam

4. Introduction to Fluid Mechanics by Robert N.Fox & Alan T.Macnold

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	-	-	-	-	-	-	-	-	2	1	-	-
CO2	3	2	3	-	1	-	2	2	-	-	2	3	1	2	-
CO3	3	-	1	-	-	-	-	2	-	-	-	2	3	2	1
CO4	1	-	3	-	-	-	-	1	1	-	2	2	2	3	1
CO5	2	-	3	-	-	-	-	1	-	-	-	2	2	3	1

Structural Analysis-II

Sem-V

General Course Information:

Course Code:PCC-CVE303-T Course Credits: 3 Mode: Lecture (L) Type: PCC Contact Hours: 3 hours (L) Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20marks, class performance measured through percentage of lecture attended (4 marks), assignments and quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes

S. No	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Explain Statically Indeterminate Structures	L2(Understanding)
CO2	Apply Slope deflection and moment Distribution Methods and Column Analogy Method in structural analysis	L3(Applying)
CO3	Analysis of Two hinged Arches	L4(Analyzing)
CO4	Evaluate bending stresses in beam subjected to Unsymmetrical Bending	L5(Evaluating)
CO5	Design Cable and suspension Bridges	L6 (Creating)

Unit-I

Statically Indeterminate Structures: Introduction, Static and Kinematic Indeterminacies, Castigliano's theorems, Strain energy method, Analysis of frames with one or two redundant members using Castigliano's 2^n theorem.

Unit-II

Slope deflection and moment Distribution Methods: Analysis of continuous beams & portal frames, Portal frames with inclined members.

Unit-III

Column Analogy Method: Elastic centre, Properties of analogous column, Applications to beam & frames.

Analysis of Two hinged Arches: Parabolic and circular Arches, Bending Moment Diagram for various loadings, Temperature effects, Rib shortening, Axial thrust and Radial Shear force diagrams.

Unit-IV

Unsymmetrical Bending: Introduction Centroidal principal axes of sections, Bending stresses in beam subjected to unsymmetrical bending, shear centre, shear centre for channel, Angles and Z sections.

Cable and suspension Bridges: Introduction, uniformly loaded cables, Temperature stresses, three hinged stiffening Girder and two hinged stiffening Girder**.**

Reference Books:

1. Statically Indeterminate Structures, C.K. Wang, McGraw Hill Book Co., New York
2. Advanced Structural Analysis, A.K. Jain, Nem Chand & Bros., Roorkee
3. Indeterminate Structures, R.L. Jindal, S. Chand & Co., New Delhi
.
4. Theory of Structures, Vol. I, S.P. Gupta & G.S.Pandit, Tata McGraw Hill, New Delhi.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	-	-	-	-	-	1	2	1	1	1
CO2	2	2	2	2	2	-	-	-	-	-	1	2	1	1	2
CO3	2	2	2	2	2	-	-	-	-	-	1	2	2	2	3
CO4	2	2	3	2	2	-	-	-	-	-	1	2	3	3	3
CO5	2	2	3	2	2	-	-	-	-	-	1	2	3	3	3

Surveying –II

Sem-V

General Course Information:

Course Code: PCC-CVE305-T Course Credits: 3 Mode: Lecture (L) Type: PCC Contact Hours: 3 hours (L) Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20marks, class performance measured through percentage of lecture attended (4 marks), assignments and quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes

S. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Understand mathematical adjustment of accidental errors involved in surveying measurements	L2(Understanding)
CO2	Carry out a geodetic survey, taking accurate measurements using instruments and adjusting the traverse	L3(Applying)
CO3	Plan a survey for applications such as road alignment and height of the building	L4(Analyzing)
CO4	Interpret survey data and plot topographical maps	L5 (Evaluation)
CO5	Create height maps and contours using photogrammetric measurements	L6 (Creating)

Course Contents

Unit-I

Trigonometrical Levelling: Introduction, height and distances-base of the object accessible, base of object inaccessible, geodetical observation, refraction and curvature, axis signal correction, difference in elevation between two points.

Triangulation: Triangulation systems, classification, strength of figure, selection of triangulation stations, grade of triangulation, field work of triangulation, triangulation computations, introduction to E.D.M. instruments.

Unit-II

Survey Adjustment and Treatment of Observations: Types of errors, definition of weight of an observation, most probable values, law of accidental errors, law of weights, determination of probable error (different cases with examples) principle of least squares, adjustment of triangulation figures by method of least squares.

Unit-III

Astronomy: Definitions of astronomical terms, star at elongation, star at prime vertical star at horizon, star at culmination, celestial coordinate systems, Napier's rule of circular parts, various time systems: sidereal, apparent, solar and mean solar time, equation of time-its cause.

Unit-IV

Elements of Photo-grammetry: Introduction: types of photographs, types of aerial photographs, aerial camera and height displacements in vertical photographs, stereoscopic vision and stereoscopies, height determination from parallax measurement, flight planning

Introduction of remote sensing and its systems: Concept of G.I.S and G.P.S. -Basic Components, data input, storage & output.

REFERENCE BOOKS:

1. Surveying Vol.2 by B.C.Punmia
2. Surveying Vol.3 by B.C.Punmia
3. Surveying Vol2 by T.P.Kanitkar
4. Higher Surveying by A M Chandra

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	-	-	-	-	-	1	2	1	1	1
CO2	2	2	2	2	2	-	-	-	-	-	1	2	1	2	2
CO3	2	2	2	2	2	-	-	-	-	-	1	2	2	3	3
CO4	2	2	2	2	2	-	-	-	-	-	1	2	3	3	3
CO5	3	2	2	2	2	-	-	-	-	-	1	2	3	3	3

Design of Concrete Structures-I

Sem-V

General Course Information:

Course Code: PEC-CVE307-T Course Credits: **3** Mode: Lecture (L) Type: PCC Contact Hours: 3 hours (L) Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20marks- class performance measured through percentage of lecture attended (4 marks)- assignments and quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination- nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes

S. No.	**Course outcomes** At the end of the course students will be able to:	RBT* Level
CO1	Recall various aspects of the Design of concrete structures	L1 (Remembering)
CO2	Explain the basic and application aspects of design of concrete structures	L2 (Understanding)
CO3	Choose appropriate design of different type of concrete structures for different type of civil work.	L3 (Applying)
CO4	Examine Limit State of Collapse for flexure- Shear- bond torsion and compression etc.	L4 (Analyzing)
CO5	Designdifferent type of concrete structures for various types of civil work.	L6 (Creating)

*Revised Bloom's Taxonomy

Course Contents

UNIT I

Introduction*:* Reinforced concrete- definition- properties of materials- grades of concrete and reinforcing steel- stress-strain curves- permissible stresses- shrinkage- creep- design philosophies working stress design- ultimate strength and limit state design method.

Limit State Design Method: Introduction- Limit States- Characteristic values- characteristic strength- characteristic loads- design values for materials and loads- factored loads.

UNIT II

Limit State of Collapse (Flexure): Types of failures- assumptions for analysis and design of singly reinforced- doubly reinforced sections- and flanged sections- Design of Lintels- Design of one-way slabs and two-way rectangular slabs- Circular slabs: Slabs with different edge conditions

Limit State of Collapse (Shear- bond and torsion): Introduction - Design for shear- structural components subjected to torsion- design of rectangular beam section for torsion- development length- continuation of reinforcement (beyond cut off points).

Limit State of Collapse (Compression): Columns and their classification- reinforcement in columns- assumptions- short and long (both tied and helical) columns subjected to axial load- short columns subject to axial- uniaxial and biaxial bending- Interaction Diagrams

UNIT III

Limit State of Serviceability*:* Deflection- effective span to effective depth ratio- modification factors for singly reinforced- doubly reinforcement and flanged beams- crack formation and its control.

UNIT IV

Limit State Design of miscellaneous structures: Design of isolated footings- Design of staircases.

Introduction to Working Stress Design Method : Application of SP 16 and Detailing of Reinforcement: Use of SP: 34- Codal Provision for RC Elements: (I) General (II) for ductility

REFERENCE BOOKS:

1. Design of Reinforced Concrete Structures-P.Dayaratnam-Oxford& IBH Pub.-N.Delhi.
2. Reinforced Concrete-Limit State Design- A.K.Jain- Nem Chand &Bros.-Roorkee.
3. Reinforced Concrete- I.C.Syal&A-K-Goel- A.H-Wheeler&Co.Delhi.
4. Reinforced Concrete Design- S.N.Sinha- TMH Pub.-N.Delhi.
5. SP-16(S&T)-1980- 'Design Aids for Reinforced Concrete to IS:456- BIS- N.Delhi.
6. SP-34(S&T)-1987 'Handbook on Concrete Reinforcement and Detailing'- BIS- N.Delhi.
7. Reinforced Concrete Design – Pillai and Menon- TMH- New Delhi.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	1	-	-	-	-	-	1	2	-	1	2
CO2	2	2	1	1	1	-	-	-	-	-	1	2	-	1	2
CO3	2	2	3	2	2	-	-	-	-	-	2	2	2	3	3
CO4	2	2	3	3	2	-	-	-	-	-	1	2	2	3	3
CO5	2	2	3	3	1	-	-	-	-	-	1	2	3	3	3

Advanced Fluid Mechanics Lab

Sem-V

General Course Information:

Course Code: PCC-CVE301-P Course Credits: 1 Mode: Practical (P) Type: PCC Contact Hours: 2 hours (P) Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20marks, class performance measured through percentage of practical attended (4 marks), assignments and quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes

S. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO 1	Explain basic properties of fluids and its application.	L2(Understanding)
CO 2	Employ various conditions in respect to the flow of fluids and the concept of floating bodies.	L3(Applying)
CO 3	Examine properties and functioning of centrifugal pump.	L4(Analyzing)
CO 4	Determine the flow in various pipe fittings.	L5(Evaluating)
CO 5	To develop the momentum characteristics of a given jet.	L6(Creating)

LIST OF EXPERIMENTS:

1 To determine the coefficient of drag by Stoke's law for spherical bodies.

2 To study the phenomenon of cavitation in pipe flow.

3 To determine the critical Reynold's number for flow through commercial pipes.

4 To determine the coefficient of discharge for flow over a broad crested weir.

5 To study the characteristics of a hydraulic jump on a horizontal floor and sloping glacis including friction blocks.

6 To study the scouring phenomenon around a bridge pier model.

7 To study the scouring phenomenon for flow past a spur.

8 To determine the characteristics of a centrifugal pump.

9 To study the momentum characteristics of a given jet.

10 To determine head loss due to various pipe fittings.

REFERENCE BOOKS:

1. Hydraulics & Fluid Mechanics by P.N.Modi and S.M.Seth
2. Fluid Mechanics by R. K. Bansal
3. Flow in Open Channels by S.Subraminayam
4. Introduction to Fluid Mechanics by Robert N.Fox & Alan T.Macnold

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	-	-	-	-	-	1	2	1	1	1
CO2	2	1	1	2	1	-	-	-	-	-	1	2	1	1	1
CO3	2	2	2	2	1	-	-	-	-	-	1	2	1	2	2
CO4	2	2	2	2	1	-	-	-	-	-	1	2	2	3	3
CO5	2	2	2	2	1	-	-	-	-	-	1	2	2	3	3

Structural Analysis-II Lab

Sem-V

General Course Information:

Course Code: PCC-CVE303-P Course Credits: 1 Mode: Practical (P) Type: PCC Contact Hours: 2 hours (P) Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20marks, class performance measured through percentage of practical attended (4 marks), assignments and quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Basic application of mechanics involved commonly in the structures.	L2(Understanding)
CO2	Get the desired values of the resultant action in response to the agitation on the structures.	L3(Applying)
CO3	Various techniques to analyse the structures following the slope and deflection approach.	L4(Analyzing)
CO4	Evaluation of trusses or forces in each member of trusses using simplified approach.	L5(Evaluating)
CO5	Develop qualitative diagrams showing the displaced shape, bending moments	L6(Creating)

LIST OF EXPERIMENTS:

1. Experiment on a two hinged arch for horizontal thrust & influence line for Horizontal thrust
2. Experimental and analytical study of a 3-bar pin-jointed Truss.
3. Experimental and analytical study of deflections for unsymmetrical bending of a Cantilever beam.
4. Begg's deformeter- verification of Muller Breslau principle.
5. Experimental and analytical study of an elastically coupled beam.
6. Sway in portal frames - demonstration.
7. To study the cable geometry and statics for different loading conditions.
8. To plot stress-strain curve for concrete.

Reference Books:

1. Statically Indeterminate Structures, C.K. Wang, McGraw Hill Book Co., New York
2. Advanced Structural Analysis, A.K. Jain, Nem Chand & Bros., Roorkee
3. Indeterminate Structures, R.L. Jindal, S. Chand & Co., New Delhi

.

4. Theory of Structures, Vol. I, S.P. Gupta & G.S.Pandit, Tata McGraw Hill, New Delhi.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	1	-	-	-	1	2	1	-	1
CO2	3	2	2	1	-	-	-	-	-	-	1	1	2	-	1
CO3	1	2	2	1	1	-	-	-	-	-	1	1	3	1	2
CO4	1	2	3	3	1	-	-	-	-	-	1	1	1	2	3
CO5	1	2	3	3	-	-	-	-	-	-	2	1	1	2	3

Surveying-II Lab

Sem-V

General Course Information:

Course Code: PCC-CVE305-P Course Credits: 1 Mode: Practical (P) Type: PCC Contact Hours: 2 hours (P) Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20marks, class performance measured through percentage of practical attended (4 marks), assignments and quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

Course outcomes

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Understand Theodilite along with chain/tape, compass on the field	L2(Understanding)
CO2	Apply Geometric and trigonometric principles of basic surveying calculations	L3(Applying)
CO3	Plan survey , taking accurate measurements , filed booking, plotting and adjustment of errors	L4(Analyzing)
CO4	Evaluate various types of surveys ,a s part of surveying team	L5(Evaluating)
CO5	Create drawing techniques in the development of topographic map	L6(Creating)

LIST OF EXPERIMENTS:

1. Theodilite Surveying
2. Single Plane observation of trigonometrically leveling
3. Two Plane Method
4. Determination of tachometric constants
5. Tangent Tachometry
6. Subtense Bar
7. Setting out of curves , building layout
8. Total Station

REFERENCE BOOKS:

1. Surveying Vol.2 by B.C.Punmia
2. Surveying Vol.3 by B.C.Punmia
3. Surveying Vol2 by T.P.Kanitkar

4. Higher Surveying by A M Chandra

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	1	-	-	-	1	2	1	-	1
CO2	3	2	2	1	-	-	-	-	-	-	1	1	2	-	1
CO3	1	2	2	1	1	-	-	-	-	-	1	1	3	1	2
CO4	1	2	3	3	1	-	-	-	-	-	1	1	1	2	3
CO5	1	2	3	3	-	-	-	-	-	-	2	1	1	2	3

Design of Concrete Structures-I Lab

Sem-V

General Course Information:

Course Code: PCC-CVE307-P Course Credits: 1 Mode: Practical (P) Type: PCC Contact Hours: 2 hours (P) Examination Duration: 03 hours.	**Course Assessment Methods (Internal: 30; External: 70)** Two minor test each of 20marks, class performance measured through percentage of practical attended (4 marks), assignments and quiz etc. (6 marks) and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answer type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the four units. All questions carry equal marks.

S. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1	Understand the structural drawings of various building components	L2(Understanding)
CO2	Apply the coding provisions of Indian Standards for detailing	L3(Applying)
CO3	Use the Auto Cad software tool for drawing concrete structures	L4(Analyzing)
CO4	Evaluate drawings of concrete structures	L5 (Evaluating)
CO5	Design concrete structures using Auto Cad software	L6 (Creating)

Students will be able to do:

Structural Drawings through AUTOCAD of the followings

1. Singly reinforced concrete beams
2. Doubly reinforced concrete beams
3. Cracking pattern of reinforced concrete beams
4. Simply supported and cantilever slabs
5. Flat slabs
6. Two way slabs
7. Columns.
8. Footings.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	1	2	-	-	-	-	-	1	1	1	1	1
CO2	1	2	2	1	2	-	-	-	-	-	1	1	1	2	2
CO3	1	1	2	1	3	-	-	-	-	-	1	2	2	2	2
CO4	2	1	3	2	3	-	-	-	-	-	1	2	3	3	3
CO5	2	2	3	2	3	-	-	-	-	-	1	2	3	3	3