

# Engineering Mechanics

## General Course Information

Course Code ESC-ME201-T Course Credits: 3 Mode: Lecture (L) Type: ESC Contact Hours: 3 hours (L) Examination Duration: 03 hours	<b>Course Assessment Methods (internal: 30; external: 70)</b> Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (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 answers 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 remaining four units. All questions carry equal marks.
--	--

## Course Outcomes

Sr. No.	Course Outcomes	RBT Level
CO1	Students will be able to describe scalar and vector techniques for analyzing forces in statically determinate structures.	L1
CO2	Students will be able to locate centroid, centre of gravity of different types of symmetrical and unsymmetrical sections.	L2
CO3	Students will be able to apply Newton's laws of Motions to solve real-world problems.	L3
CO4	Students will be able to examine the physical significance of moment of inertia e.g in railway, flyovers, Bridges, automobiles etc.	L4

## Course Contents

### UNIT-I

**Review of Basic Force System:** Laws of mechanics, Vector algebra review, Moment of a force about a point and axis, Couple and couple moment, Addition and subtraction of couples, Moment of a couple about a line, Resultant of a force system. Problems

**Equilibrium of forces:** Introduction, Lami's theorem, Methods for the equilibrium of coplanar forces, Analytical method for the equilibrium of coplanar forces, free body diagram, general equations of equilibrium, Tension in a string, Problems

### UNIT-II

**Truss and Frames:** Types of frames, Types of stresses in frames (Tensile and compressive), Assumptions for forces in the members of a perfect frame, Analytical methods for the forces, Method of joints, Method of sections (or Method of moments), simply supported trusses, Problems

**Centroid and centre of gravity:** Definition, Centroid of regular shapes, Symmetrical sections, Unsymmetrical sections, Reference axis, Centre of gravity of solid bodies, Centroid and centre of gravity of hollow sections. Problems

### UNIT-III

**Moment of Inertia:** Introduction and significance, Parallel axis theorem, Perpendicular axis theorem, Mass moment of inertia, Area moment of inertia of regular shapes: L-sections, T-sections, I-sections, Moment of inertia of unsymmetrical sections, hollow sections, Product of inertia, Properties of product of inertia, Principal axis. Problems

**Particle dynamics-** Rectilinear motion, Plane curvilinear motion (rectangular, path and polar coordinates), Newton's 2<sup>nd</sup> law (rectangular, path and polar coordinates), Work- kinetic energy, power, potential energy, Impulse-momentum (linear, angular), Impact (Direct and oblique). Problems

#### UNIT-IV

**Virtual work:** Introduction, Concept and principle of virtual work, Virtual displacements, Sign conventions, Applications of principle of virtual work on beams carrying point load, uniformly distributed load, Applications of virtual work on ladders. Problems

**Friction:** Introduction, Types of friction, Laws of friction, Equilibrium of a body on a rough horizontal plane and inclined plane, Equilibrium of a body on a rough inclined plane subjected to a force acting along the inclined plane, Equilibrium of a body on a rough inclined plane subjected to a force acting horizontally. Problems

#### Text and Reference Books

1. Irving H. Shames, Engineering Mechanics, 4th Edition, Prentice Hall
2. R.C. Hibbler (2017), Engineering Mechanics: Statics and Dynamics, Pearson Press.
3. Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education
4. Reddy Vijaykumar K. and K. Suresh Kumar (2010), Singer's Engineering Mechanics
5. Bansal R.K.(2015), A Text Book of Engineering Mechanics, Revised eighth edition, Laxmi Publications
6. Khurmi R.S., Engineering Mechanics, 20<sup>th</sup> revised edition, S. Chand & Co.
7. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

#### Course Articulation Matrix

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

## Introduction to Civil Engg.

### Sem-III

#### General Course Information:

Course Code: HSMC-CVE201-T Course Credits: 3 Mode: Lecture (L) Type: HSMC Contact Hours: 3 hours (L) Examination Duration: 03 hours.	<b>Course Assessment Methods (Internal: 30; External: 70)</b> 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	RBT* Level
	At the end of the course students will be able to:	
CO1.	Introduction to what constitutes Civil Engineering	L1(Remembering)
CO2.	Identifying the various areas available to pursue and specialize within the overall field of Civil Engineering	L2(Understanding)
CO3.	Analyzing various possibilities of a career in this field	L4(Analyzing)
CO4.	Evaluate the depth of engagement possible within each of these areas	L5(Evaluating)

#### Course Contents

##### UNIT – I

##### **Construction materials**

Stones -Characteristics of good building stones-common building stones and their uses

Bricks-Characteristics of good bricks-classification of bricks and their uses-

Timber-Classification of Timber and their uses-Cement-Types of cement and their uses

##### **Components of building**

Components of sub structure and their functions-Components of super structure and their functions -Types of forces – compression, tension, shear – Stress – Strain-Concrete- Ingredients of concrete and its importance in construction - Steel- Types of steel and its importance in construction

##### UNIT – II

##### **Survey and Highway Engineering**

Definition and classification of surveying – linear and angular measurements - levelling

Modes of transportation – Classification of highways - Classification of pavements – Super elevation.

##### UNIT – III

##### **Irrigation and Water supply**

Definition and classification of irrigation – Irrigation structures – dams, weirs, cross drainage works, canal drops-

Quality of water-Treatment methods

## UNIT – IV

### Geotechnical Engineering

Origin of soil – types of soil – bearing capacity of soil – Types of foundation – shallow and deep

#### REFERENCES

1. B C Punmia, Ashok K Jain, Arun K Jain, (1st Edition, 2003), “Basic Civil Engineering”, Laxmi Publications (P) Ltd.
2. G K Hiraskar, (1st Edition, 2004), “Basic Civil Engineering”, Dhanpat Rai Publication.

#### Course Articulation Matrix:

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

**Surveying-I**  
**Sem-III**

**General Course Information:**

Course Code: PCC-CVE201-T Course Credits: 3 Mode: Lecture (L) Type: PCC Contact Hours: 3 hours (L) Examination Duration: 03 hours.	<p><b>Course Assessment Methods (Internal: 30; External: 70)</b> 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.</p> <p>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.</p>
---	---

**Course outcomes**

Sr. No.	Course outcomes	RBT* Level
	At the end of the course students will be able to:	
CO1	Calculate angles, distances and levels	<b>L1(Remembering)</b>
CO2	Identify data collection methods and prepare field notes	<b>L2(Understanding)</b>
CO3	Demonstrate the working principles of survey instruments	<b>L3(Applying)</b>
CO4	Estimate measurement errors and apply corrections	<b>L5(Evaluating)</b>
CO5	Interpret survey data and plot topographical maps	<b>L6(Creating)</b>

**Course Contents**

**Unit-I**

**Fundamental Principles of Surveying:** Definition, objects, classification, fundamental principles, methods of fixing stations.

**Measurement of distances:** Direct measurement, instruments for measuring distance, instruments for making stations, chaining of line, errors in chaining, tape corrections examples.

**Compass and Chain Traversing:** Methods of traversing, instruments for measurement of angles-prismatic and surveyor's compass, bearing of lines, local attraction, examples.

**Unit-II**

**Leveling:** Definition of terms used in leveling, types of levels and staff, temporary adjustment of levels, principles of leveling, reduction of levels, booking of staff readings, examples, contouring, characteristics of contours lines, locating contours, interpolation of contours.

**Plane Table Surveying:** Plane table, methods of plane table surveying, radiation, intersection, traversing and resection, two point and three point problems.

**Unit-III**

**Theodolite and Theodolite Traversing:** Theodolites, temporary adjustment of theodolite, measurement of angles, repetition and reiteration method, traverse surveying with theodolite, checks in traversing, adjustment of closed traverse, examples.

**Tacheometry:** Uses of tacheometry, principle of tacheometric surveying, instruments used in tacheometry, systems of tacheometric surveying-stadia system fixed hair method, determination of tacheometric constants, tangential systems, examples.

**Unit-IV**

**Curves:** Classification of curves, elements of simple circular curve, location of tangent points-chain and tape methods, instrumental methods, examples of simple curves. Transition Curves-Length and types of transition curves, length of combined curve, examples.

Vertical Curves: Necessity and types of vertical curves.

**REFERENCE BOOKS**

1. Surveying Vol.I & II by B.C.Punmia
2. Surveying by C. Venkatramaiah
3. Surveying Vol.I by T.P.Kanitkar
4. Fundamentals of Surveying by S. K. Roy
5. Surveying and levelling by R. Subramaniam
6. Chandra A. M., Higher Surveying, New Age International Publishers, 2007.
7. Chandra A. M., Plane Surveying, New Age International Publ., 2007.

**Course Articulation Matrix:**

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

## Engineering Geology

### Sem-III

#### General Course Information:

Course Code: PCC-CVE203-T Course Credits: 3 Mode: Lecture (L) Type: PCC Contact Hours: 3 hours (L) Examination Duration: 03 hours.	<b>Course Assessment Methods (Internal: 30; External: 70)</b> 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	RBT* Level
	At the end of the course students will be able to:	
CO1	Describe weathering process and mass movement of rocks to soil	L1(Remembering)
CO2	Distinguish geological formations	L2(Understanding)
CO3	Identify geological structures and processes for rock mass quality	L3(Applying)
CO4	Identify subsurface information and groundwater potential sites through geophysical investigations	L5(Evaluating)
CO5	Apply geological principles for mitigation of natural hazards and select sites for dams and tunnels	L6(Creating)

#### Course Contents

##### Unit-I

**General Geology:** Branches and scope of geology, Importance of geology in Civil engineering. Earth-surface features and internal structure, weathering of rocks.

**Mineralogy:** Definition of a crystal and mineral, physical properties in mineral identification, rock forming minerals and their identification – quartz and its varieties, feldspar, hornblende, olivine, mica, garnet, kyanite, calcite, talc, bauxite, corundum, gypsum, fluorite, apatite, beryl, barite, asbestos, magnetite, hematite.

##### UNIT-II

**Petrology:** Formation and classification of rocks – Igneous, Sedimentary and metamorphic rocks, their texture and structures, properties of granite, pegmatite, dolerite, gabbro, charnockite, basalt, sandstone, conglomerate, breccia, limestone, shale, laterite, schist, gneiss, quartzite, marble, khondalite and slate. Drilling Techniques, Core Recovery, RQD, Engineering Properties of Rocks

**Structural Geology:** Outcrop, Strike and dip, types and classifications of folds, faults, joints, unconformities.

**Engineering properties of rocks:** Drilling, Core recovery, RQD, Sample preparation, tests on rock samples - compression, tensile, shear and slake durability tests.

##### UNIT-III

**Ground Water:** Water tables, aquifers, occurrence of ground water in different geological formations, springs, selection of a site for well sinking and ground water investigations.

**Earthquakes and Landslides:** Causes and effects of earthquakes and landslides, Remedial measures to prevent damage for engineering structures.

**Subsurface Investigations:** Soil Profile, Geophysical methods – Electrical Resistivity and Seismic refraction methods.

#### UNIT-IV

**Dams:** Types of dams, Requirements of dam sites, preliminary and detailed geological investigations for a dam site. Case histories of dam failures and their causes. Geology of the major dam sites of India. Factors affecting the seepage and leakage of reservoir and the remedial measures.

**Tunnels:** Purpose of tunneling, geological considerations for tunneling, geothermal step, over break, stand up time, and logging of tunnels.

#### REFERENCE BOOKS :

1. Parbin Singh., “Engineering and General Geology”, Katson Publishers, 2009
2. David George Price, “Engineering Geology: Principles and Practice”, Springer, 2009.
3. Chennakesavulu, N., “Text book of Engineering Geology”, Mac Millan Ltd., New Delhi, 2009.
- 4.. K.V.G.K. Gokhale, “Principles of Engineering Geology”, BS Publications, Hyderabad, 2005.

#### Course Articulation Matrix:

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



## Disaster Preparedness & Planning

### Sem-III

#### General Course Information:

Course Code: PCC-CVE205-T Course Credits: 2 Mode: Lecture (L) Type: PCC Contact Hours: 2 hours (L) Examination Duration: 03 hours.	<b>Course Assessment Methods (Internal: 30; External: 70)</b> 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	RBT* Level
	At the end of the course students will be able to:	
CO1	Ability to understand Categories of Disasters	L2(Understanding)
CO2	Realization of the responsibilities to society	L3(Applying)
CO3	Analyzing Relationship between Development and Disasters	L4(Analyzing)
CO4	The application of Disaster Concepts to Management	L5(Creating)

#### Course Contents

##### **Unit I**

**Introduction** - Concepts and definitions: disaster, hazard, vulnerability, risks- severity, frequency and details, capacity, impact, prevention, mitigation).

**Disasters** - Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); man-made disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.

##### **Unit II**

**Disaster Impacts** - Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.

##### **Unit III**

**Disaster Risk Reduction (DRR)** - Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post-disaster environmental response(water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

#### Unit IV

**Disasters, Environment and Development** - Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land-use changes,urbanization etc.), sustainable and environmental friendly recovery; reconstruction and development methods.

#### REFERENCE BOOKS

1. <http://ndma.gov.in/> (Home page of National Disaster Management Authority)
2. Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
3. Singh B.K., 2008, Handbook of Disaster Management: Techniques & Guidelines, Rajat Publication.
4. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation
5. . Disaster Medical Systems Guidelines. Emergency Medical Services Authority, State of California,EMSA no.214, June 2003

#### Course Articulation Matrix:

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

## Surveying-I Lab

### Sem-III

#### General Course Information:

Course Code: PCC-CVE201-P Course Credits: 1 Mode: Practical (P) Type: PCC Contact Hours: 2 hours Examination Duration: 03 hours.	<b>Course Assessment Methods (Internal: 30; External: 70)</b> 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	RBT* Level
	At the end of the course students will be able to:	
CO1	Calculate angles, distances and levels	L1(Remembering)
CO2	Identify data collection methods and prepare field notes	L2(Understanding)
CO3	Estimate measurement errors and apply corrections	L5(Evaluating)
CO4	Interpret survey data and plot topographical maps	L6(Creating)

#### LIST OF EXPERIMENTS:

- 1 Chain surveying: Chaining and chain traversing.
- 2 Compass traversing.
- 3 Plane table Survey methods of plane table surveying, two point problem.
- 4 Plane table Survey methods of plane table surveying three point problem.
- 5 Leveling: Profile leveling
- 6 Levelling : longitudinal section and cross sections levelling
7. Reciprocal leveling.
8. Permanent adjustment of level.
9. Contouring and preparation contour map.
10. Use of Tangent Clinometers

#### REFERENCE BOOKS

1. B.C. Punmia, Ashok Kumar Jain, Ashok Kr. Jain, Arun Kr. Jain., Surveying I & II, Laxmi Publications, 2005.
2. . Chandra A. M., Plane Surveying, New Age International Publ., 2007.
3. Charles D Ghilani, Paul R Wolf., Elementary Surveying, Prentice Hall, 2012.
4. Surveying Vol.I & II , B.C.Punmia
5. Surveying by C. Venkatramaiah
6. Surveying Vol.I by T.P.Kanitkar
7. Fundamentals of Surveying by S. K. Roy
8. Surveying and levelling by R. Subramaniam

**Course Articulation Matrix:**

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

## Engineering Geology Lab

### Sem-III

#### General Course Information:

Course Code: PCC-CVE203-P Course Credits: 1 Mode: Practical (P) Type: PCC Contact Hours: 2 hours (P) Examination Duration: 03 hours.	<b>Course Assessment Methods (Internal: 30; External: 70)</b> 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	RBT* Level
	At the end of the course students will be able to:	
CO1	Describe different types of ores and minerals	L2(Understanding)
CO2	Distinguish geological formations	L2(Understanding)
CO3	Identify geological structures and processes for rock mass quality	L3(Applying)
CO4	Identify subsurface information and groundwater potential sites through geophysical investigations	L5(Evaluating)

#### LIST OF EXPERIMENTS:

1. Introduction to Crystallography – Identification of Crystals.
2. Introduction of minerals and the study of Physical properties, Identification of Quartz and feldspars.
3. Identification of pyroxenes and Amphiboles and other silicates.
4. Identification of important economic minerals.
5. Identification of important ore deposits.
6. Identification of Igneous rocks.
7. Identification of Sedimentary rocks.
8. Identification of metamorphic rocks.
9. Structural geology- strike and dip, three and 3-point problems point problems.

#### REFERENCE BOOKS

1. Chennakesavulu, N., “Text book of Engineering Geology”, MacMillan Ltd., New Delhi, 2009.
2. Structural Geology Manual.
3. . Parbin Singh., “Engineering and General Geology”, Katson Publishers, 2009
4. David George Price, “Engineering Geology: Principles and Practice”, Springer, 2009.
5. . Chennakesavulu, N., “Text book of Engineering Geology”, Mac Millan Ltd., New Delhi, 2009.
6. K.V.G.K. Gokhale, “Principles of Engineering Geology”, BS Publications, Hyderabad, 2005.

**Course Articulation Matrix:**

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