**Program Name** : **Civil Engineering Program Group**

**Program Code** : **CE/CR/CS**

**Semester** : **Fifth**

**Course Title** : **Public Health Engineering**

**Course Code** : **22504**

## 1. RATIONALE

The Environment and Public Health Engineering works for minimizing the impact of Engineering and Technology on the natural resources. Rapidly increasing urbanization, is stretching resources and infrastructure, and threatening environmental quality. To maintain better public health one must have safe quality of drinking water supply, effective methods for disposal of domestic and industrial waste and pollution free environment. The detailed knowledge about various sources of water supply, quality parameters of public water purification and conveyance of water will be useful in planning suitable water supply scheme for town/city. Topics on domestic sewage, conveyance of sewage in sewers analysis and treatment of sewage will be useful for safe disposal of this waste. Emerging trends in sanitation and water supply will provide latest know to the students. Thus the subject will be helpful in bringing up general public health to desired safe level in respect of water supply and disposal of waste.

## 2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Execute the efficient water supply and sanitary system.**

## 3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a Identify the sources and characteristics of water and wastewater.
b Estimate the quantity of drinking water and wastewater generated.
c Draw labeled systems of plumbing for building sanitation.
d Draw the flow diagram for process of treatment of water and wastewater.
e Identify various accessories for efficient conveyance and distribution of water.

## 4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme | | | Credit (L+T+P) | Examination Scheme | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | | | | | | Practical | | | | | |
| L | T | P | | Paper Hrs. | ESE | | PA | | Total | | ESE | | PA | | Total | |
| | | | | | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min |
| 3 | - | 2 | 5 | 3 | 70 | 28 | 30* | 00 | 100 | 40 | 25# | 10 | 25 | 10 | 50 | 20 |

*(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.*

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

## 5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

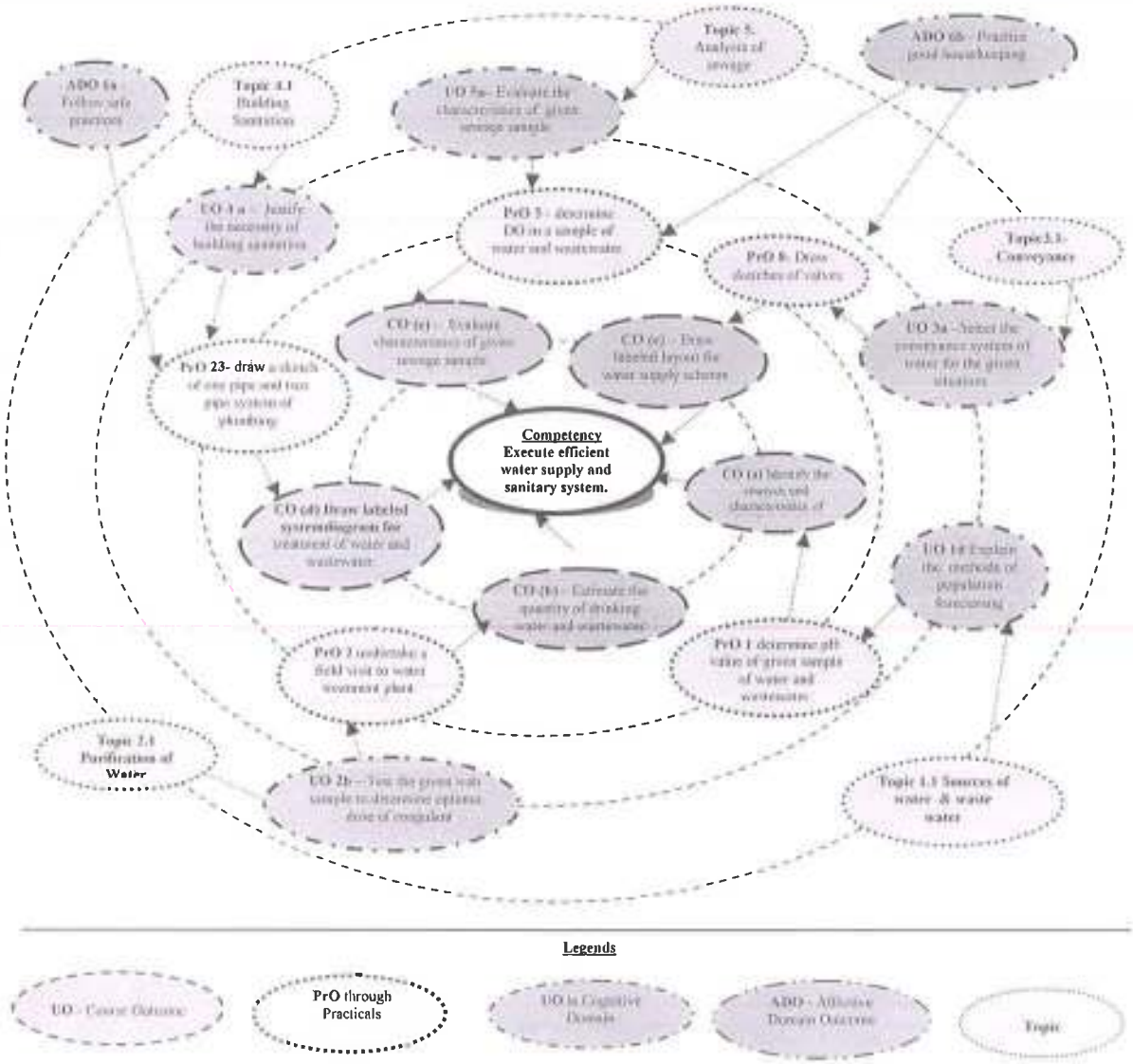


**Figure 1 - Course Map**

## 6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|---|---|---|---|

| S. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|---|---|---|---|
| 1 | Determine pH value of given sample of water. | I | 02* |
| 2 | Determine the turbidity of the given sample of water. | I | 02* |
| 3 | Determine residual chlorine in a given sample of water. | I | 02 |
| 4 | Determine suspended solids dissolved solids and total solids of given sample of water. | I | 02 |
| 5 | Determine the dissolved oxygen in a sample of water. | I | 02* |
| 6 | Undertake a field visit to water treatment plant. | II | 02* |
| 7 | Determine the optimum dose of coagulant in the given raw water sample by jar test. | II | 02* |
| 8 | Draw sketches of various valves used in water supply pipe line | III | 02 |
| 9 | Draw a sketch of one pipe and two pipe system of plumbing | IV | 02 |
| 10 | Determine B.O.D. of given sample of waste water. | V | 02 |
| 11 | Determine pH value of given sample of wastewater. | V | 02* |
| 12 | Determine suspended solids dissolved solids and total solids of given sample of wastewater. | V | 02 |
| 13 | Determine the dissolved oxygen in the given sample of wastewater. | V | 02* |
| 14 | Determine C.O.D. of given sample of waste water. | V | 02 |
| 15 | Prepare a report of a field visit to wastewater treatment plant | V | 02* |
| 16 | Prepare a report of the field visit to bio gas /gobar gas plant in your locality | V | 02 |
| | Total | | 32 |

***Note***

*i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

*ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

| S. No. | Performance Indicators | Weightage in % |
|---|---|---|
| a. | Performance of practical in the laboratory / field visit | 60 |
| b. | Observation /data collection | 10 |
| c. | Results and conclusions | 10 |
| d. | Answer to sample questions | 10 |
| e. | Submit report in time | 10 |
| **Total** | | **100** |

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipments.

e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

## 7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

| S. No. | Equipment Name with Broad Specifications | PrO. S. No. |
|---|---|---|
| 1.1 | Digital pH meter (4 Digit Display (LED), 0 to 1000 mV, Resolution: 0.01 pH, Manual Temp, Compensation: 0 to 80$^0$C.) | 1, 11 |
| 1.2 | Digital Turbidity Meter.(Range 0 to 200NTU, Resolution 1NTU, Accuracy: ± 3% FS, ± 1Digit, Display3½ Digit 7-Segment LED Light Source6V, 0.3Amp Tungsten Lamp, Detector: Photodiode, Sample System:30 mm Clear Glass Test Tubes, Power230 V ± 10% AC, 50 Hz, Accessories Test tube Set of 5, Operation Manual, Dust Cover | 2 |
| 1.3 | Orthotolodine test kit ( free and total **chlorine testing** for EPA reporting over the range of 0-4 mg/L.) | 3 |
| 1.4 | Electric Oven with digital control (Temperature: 300$^0$C., 25 kg capacity) | 4, 12 |
| 1.5 | Digital DO meter (Range: 0 to 20 ppm, Resolution : 0.1 ppm, Temperature compensation :0 to 50 $^0$C.) | 5, 13 |
| 1.6 | Jar Test Apparatus (Digital timer: 1 to 99 minutes, material: Stainless steel, Power: Electric supply, Range: 25 to 250 rpm, with 6 glass jars of 1000 mL) | 7 |
| 1.7 | BOD incubator with BOD bottles (Rated Voltage: AC 220V±10% 50Hz, Power: 2800W, Temperature Controlling Mode: Digital Display, Temperature Controlling Point: 24°c, 93.5°c,Temperature Controlling Precision: ±0.1°c) | 10 |
| 1.8 | Digital COD digester (Glassware: 15 Reaction Vessels & Air Condensers, Temperature: 150°C ± 1%, Capacity: 15 Samples at a time, Sample Size: 20 ml, Range: 0 to 500 ppm without dilution, Timer: 2 hours timer with Buzzer , Power Requirement: 230v 1000w | 14 |

## 8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| **Unit – I Sources, Quantity** | 1a. Describe various surface and sub surface sources of water in a given situation. | 1.1 **Sources of water:** Surface and Subsurface sources of water, Intake Structures, Definition and types, Factors |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| **and Quality of water** | 1b. Explain various types of intake structures for the given source of water.<br>1c. Draw flow diagram of water supply scheme in the given situation.<br>1d. Explain the methods of forecasting population in the given situation.<br>1e. Undertake physical, chemical and biological tests for the given sample of water.<br><br>Draw a neat labelled sketc h of cross section of "Rapid sand Gravity Filter" | governing the location of an intake structure, Types of intakes.<br>1.2 **Quantity of water:** Need to protect water supplies, flow diagram of water supply scheme, function of units, Demands of water, Factors affecting rate of demand, Variations of water demands, Forecasting of population, Methods of forecasting of population, (Simple problems on forecasting of population), Design period, Estimating of quantity of water supply required for city or town.<br>1.3 **Quality of water:** Need for analysis of water, Characteristics of water- Physical, Chemical and Biological, Testing of water for Total solids, hardness, chlorides, dissolved Oxygen, pH, Fluoride, Nitrogen and its compounds, Bacteriological tests, E coli, B coli index, MPN, Sampling of water, Water quality standards as per I.S.10500. |
| **UNIT II Purification of water** | 2a. Explain the term, "Aeration of water" in the given situation<br>2b. Test the given water sample to determine the optimum dose of coagulant.<br>2c. Describe the process of filtration of water in the given situation.<br>2d. Differentiate between slow sand filter and rapid sand filter in the given situation.<br>2e. Describe different methods of disinfection for the given water sample.<br>2f. Explain advanced treatment methods for the water in the given situation. | **2.1 Purification of Water**: Screening- Types of screens, Aeration- objects and methods of aeration, Plain sedimentation, Sedimentation with coagulation, principles of coagulation, types of coagulants, Jar Test, process of coagulation, types of sedimentation tanks,<br>**2.2** Clariflocculator, Filtration-theory of filtration, classification of filters: slow sand filter, rapid sand filter, pressure filter, construction and working of slow sand filter and rapid sand filter. Disinfection: Objects, methods of disinfection, Chlorination- Application of chlorine, forms of chlorination, types of chlorination practices, residual chlorine and its importance, orthotolidine test, Flow diagram of water treatment plants.<br>**2.3 Miscellaneous water Treatments**: Water softening, Defluoridation techniques.<br>**2.4 Advanced Water Treatments:** Electrolysis, Reverse Osmosis. |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| **UNIT III Conveyance and Distribution of water** | 3a Select the conveyance system of water for the given area.<br>3b Select the relevant type of valve for the given pipeline of water supply.<br>3c Explain the methods of distribution of water in the given situation.<br>3d Use the relevant method for the distribution of water in the given area.<br>3e Draw the layout of water distribution system in the given situation. | 3.1 **Conveyance:** Types of Pipes used for conveyance of water, choice of pipe material, Types of joints & Types of valves- their use, location and function on a pipeline.<br>3.2 **Distribution of water:** Methods of distribution of water- Gravity, pumping, and combined system, Service reservoirs - functions and types , Layouts of distribution of water-Dead end system, grid iron system, circular system, radial system ; their suitability, advantages and disadvantages. |
| **UNIT IV Domestic sewage and System of Sewerages** | 4a. Justify the necessity of Sanitation for the given Building.<br>4b. Describe the various types of traps for the given situation with sketches.<br>4c. Describe relevant system of plumbing in the given situation.<br>4d. Draw layout plan of drainage system for the given building.<br>4e. Describe the testing procedure for the given sewers.<br>4f. Explain the necessity of manhole and drop manhole in the given sewerage system. | 4.1 **Building Sanitation: N**ecessity of sanitation, Necessity to treat domestic sewage, Definitions - Sewage, sullage, types of sewage, Definitions of the terms related to Building Sanitation- Water pipe, Rain water pipe, Soil pipe, Sullage pipe, Vent pipe, Building Sanitary fittings-Water closet – Indian and European type, flushing cistern, wash basin, sinks, Urinals.Traps- types, qualities of good trap. Systems of plumbing - one pipe, two pipe, single stack, choice of system Principles regarding design of building drainage, layout plan for building sanitary fittings (drainage plan),inspection and junction chambers, their necessity, location, size and shape, Maintenance of sanitary units.<br>4.2 **Systems of Sewerage and Sewer Appurtenances**: Types of Sewers, Systems of sewerage. Design of sewers, self cleansing velocity and non scouring velocity, Laying, Testing and maintenance of sewers. Manholes and Drop Manhole-component parts, location, spacing, construction details, Sewer Inlets, Street Inlets. |
| **UNIT V Characteristics and treatment of Sewage** | 5a. Evaluate the characteristics of given sewage sample.<br>5b. Explain the terms, "BOD and COD" for the given sample of sewage. | 5.1 **Analysis of sewage:** Characteristics of sewage, B.O.D., C.O.D. and its significance. Aerobic and anaerobic process, Maharashtra Pollution Control Board Norms for the discharge of treated |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| | 5c. Examine the quality of treated sewage as per given norms of MPCB.<br>5d. Draw flow diagram for sewage treatment plant for the given data.<br>5e. Select the relevant method of treatment of sewage in the given situation. | sewage, Objects of sewage treatment and its flow diagram.<br>5.2 **Treatment of Sewage:** Screening, Grit removal, Skimming, Sedimentation of sewage, Sludge digestion, Trickling filters, Activated sludge process, Disposal of sewage, Oxidation pond, Oxidation ditch. Septic tank (details and design criteria), Recycling and Reuse of domestic waste. |

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'*

## 9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|---|
| | | | R Level | U Level | A Level | Total Marks |
| I | Sources, Quantity and Quality of water | 08 | 04 | 08 | - | 12 |
| II | Purification of water | 12 | 04 | 06 | 08 | 18 |
| III | Conveyance and Distribution of water | 06 | 02 | 04 | 04 | 10 |
| IV | Domestic sewage and System of Sewerages | 12 | 02 | 04 | 12 | 18 |
| V | Characteristics and Treatment of Sewage | 10 | 02 | 04 | 06 | 12 |
| **Total** | | **48** | **14** | **26** | **30** | **70** |

***Legends:** R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

## 10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Prepare journals based on practical performed in laboratory.
b. Give seminar on relevant topic.
c. Undertake micro-projects.

## 11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Demonstrate students thoroughly before they start doing the practice.
g. Encourage students to refer different websites to have deeper understanding of the subject.
h. Observe continuously and monitor the performance of students in Lab.

## 12. SUGGESTED MICRO-PROJECTS

***Only one micro-project*** is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Test the water sample from locally available area to determine its characteristics..
b. Test the waste water sample from locally available area to determine its characteristics
c. Suggest the remedial measures for the control of pollution of local water source by conduct relevant study and tests.
d. Visit the site where Utilization and recycling of treated wastewater.is being implemented and prepare a detail report on it.
e. Undertake the Impact study of vehicular pollution on environment.
f. Undertake a comparative study of Solar water heater project and conventional water heater project for residential building.

## 13. SUGGESTED LEARNING RESOURCES

| S. No. | Title of Book | Author | Publication |
|---|---|---|---|
| 1 | Environmental Engineering Vol. I and Vol. II | Garg, S.K. | Khanna Publishers. New Delhi, 2017, ISBN-10: 8174091203; ISBN-13: 978-8174091 |

| S. No. | Title of Book | Author | Publication |
|---|---|---|---|
| 2 | Water Supply and Sanitary Engineering | Birdie, G. S. Birdie, J. S. | Dhanpat Rai and Sons, 2011 ISBN: 81874337954, |
| 3 | Environmental Pollution Control Engineering | Rao, C.S. | New Age International Pvt Ltd Publishers , 2006, ISBN-13: 978-8122418354 |
| 4 | Environmental Engineering | Tchobanoglous , George | Mcgraw Hill Publishers, 2013, ISBN 9789351340263 |

## 14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.cpheeo.nic.in
b. www.mpcb.gov.in.
c. http://nptel.ac.in/courses/105106119/
d. http://nptel.ac.in/courses/105104102/
e. http://nptel.ac.in/courses/105106119/33
f. www.cpcb.nic.in
g. https://mjp.maharashtra.gov.in/
h. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-85-water-and-wastewater-treatment-engineering-spring-2006/lecture-notes/
i. http://www.nitttrchd.ac.in/sitenew1/nctel/civil.php
j. www.IS 10500(2012): Drinking Water.
k. www.Eldo_PPT-IndianStandards_WWT%20(1).pdf


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