SHIVAJI UNIVERSITY, KOLHAPUR
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शिवाजी विद्यापीठ, कोल्हापूर ४१६ ००४, महाराष्ट्र
दूरध्वनी - इपीबीएक्स - २०६०९०००, अभ्यासमंडळे विभाग : ०२३१- २६०९०९४, २६०९४८७
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Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SU/BOS/Sci & Tech/410 **Date: /07/2025**

To,

1) **The Head,**
Concerned Departments,
Shivaji University, Kolhapur

2) **The Principal/ Director,**
All affiliated Engineering Colleges/ Institute,
Shivaji University, Kolhapur.

Subject: Regarding revised syllabus of **Ph. D. Coursework** under the Faculty of Science and Technology as per National Education Policy 2020.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, Nature of Question paper and equivalence of **Ph. D. Coursework** under the Faculty of Science & Technology as per National Education Policy 2020.

1.	Computer Science
2.	Food Science
3.	Environmental Science

This Syllabus, shall be implemented from the academic year **2025-26** onwards. A soft copy containing the syllabus is attached herewith and it is available on university website **www.unishivaji.ac.in NEP-2020@suk (Online Syllabus).**

You are therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dr. S. M. Kubal
Dy. Registrar

Encl. : As above.
Copy to: For Information and necessary action.

1	The Dean, All Faculty	7	P.G.Admission Section
2	Director, Board of Examination and Evaluation	8	Affiliation T. 1 & T. 2 Section
3	The Chairman, Respective Board of Studies	9	Appointment A & B Section
4	All On Exam Section	10	P.G.Seminar Section
5	B.Sc. / M.Sc. Exam Section	11	I.T. Cell / Computer Centre
6	Eligibility Section	12	Internal Quality Assurance Cell (IQAC)

SHIVAJI UNIVERSITY, KOLHAPUR

Accredited By NAAC with 'A++'
Grade Revised Syllabus For

Ph. D. Course Work

Environmental Science

Syllabus to be implemented from
2025-26

SHIVAJI UNIVERSITY, KOLHAPUR

Master of Philosophy M. Phil. / and Doctor of Philosophy [Ph. D.]

M.Phil. Ph.D. Coursework COURSE STRUCTURE

(To be implemented from Academic Year 2025-26 Onwards)

A) Pre Registration Coursework :

Sr. No.	Paper Title	Examination Scheme				
		No. of credit	Theory		Minimum passing 40%	Total Marks
			Continuous Assessment	Written Examination		
1	2	3	4	5	6	7
1	Research and Publication Ethics (RPE)	2	20	30	20	50
Written Exam : MCQ TYPE / To be Conducted faculty wise through Examination Section						

Before the confirmation of registration, the scholar has to complete Pre - Registration Coursework.
Continuous Assessment will be done through tutorials, assignments, quizzes and group discussions, Weightage will be given for active participation. Final written examination will be conducted at the end of the course

B) After Registration Pre Ph.D. Coursework:

1) Total No .of Compulsory Papers as per UGC Guideline :

Sr. No.	Subjects / Papers	Marks
1	Research Methodology, Quantitative Techniques and Computer Application.	100
2	Recent Trends in the subject concerned	100
3	Optional Paper (Based on Specialization).	100
	Total	300

2) SCHEME OF TEACHING:

Sr. No.	Paper Title	Teaching Scheme			
		Lectures in Hours	**Seminars** in Hours	**Library Work** in Hours	**Total** Hours
1	Research Methodology, Quantitative Techniques and Computer Application	40	10	10	60
2	Recent Trends in the subject concerned	40	10	10	60
3	Optional Paper (Based on Specialization)	40	10	10	60

3) SCHEME OF EXAMINATION :

Sr. No.	**Paper Title**	**Examination Scheme**				
		No. of credit	**Theory** Marks	**Internal** Marks	**Minimum Passing 40%**	**Total Marks**
1	Research Methodology, Quantitative Techniques and Computer Application	4	80	**20**	**40**	100
2	Recent Trends in the subject concerned	4	80	**20**	**40**	100
3	Optional Paper - M. Phil /Pre. Ph. D. (Based on Specialization)	4	80 Marks	20	**40**	100
				Total		300

- **Theory Examination: is to be conducted by the university with duration of 3 hours per paper.**
- **Internal Examination is to be conducted by the concerned departments or research centers in the following form:**
  1. **For paper 1 and 2 the internal evaluation will include 2 Seminars of 10 Marks each**
  2. **For paper – 3 the internal evaluation will be as follows:**

  a) Seminars (Submission and Presentation)- 10 marks

  b) Review s Literature : Submission and Presentation- 10 marks

  (Papers will have separate passing head for theory examination and internal evaluation 32+8=40)

STANDARD OF PASSING:

i) The scholar should secure minimum 40% marks to complete the course work in individual paper. M. Phil. / Ph.D. scholar has to obtain a minimum of 55% of marks or its equivalent grade in the UGC 7 - point scale in the course work in order to be eligible to continue in the programme and submit the dissertation / thesis (as per R.D. 11.9). the candidate will be allowed to reappear the examination for one, two or three papers if he / she could not achieve 55% aggregate in coursework examination.

ii) The examination shall be conducted at the end of each academic year.

iii) The evaluation of the performance of the scholars shall be as per scheme of examination.

iv) Question Paper shall be set in the view of the / in accordance with the entire syllabus and preferably covering each unit of syllabus.

NATURE OF QUESTION PAPER AND SCHEME OF MARKING:

The nature of question paper for the subject/paper shall be as indicated below:

a. Short answered questions *(Any Four Out of Six Questions)* *(20 Marks)*
b. Long answered questions *(Any Two Out of Four Questions)* *(20 Marks)*
c. Short notes *(Any Four Out of Six Questions)* *(20 Marks)*
d. Problems / Cases/Exercise Oriented Questions.
(Any One Out of Two Questions) *(20 Marks)*

Note: *Question Paper should focus on all units in the syllabus*

C) Training in Teaching/Education / Pedagogy (4 Credits) during their doctoral Period as Follow.

Sr. No	Paper Title	No. of Credit	Theory Marks	Internal Marks	Minimum Passing 40%	Total Marks	Remark
1	Training in Teaching (Theory)	2	40	10	20	50	E- Content Prepared by BOS Education
2	Training in Teaching (Practical)	2	50	-	20	50	Practical Based BOS of concerned subject (e.g. Seminar, etc.)
	Total	4	90	10	40	100	

Training is to be conducted at University department and the consequent evaluation and assessment is to be done as per the curricular framework.
(Papers will have separate passing head for theory examination and internal evaluation 32+8=40)

Shivaji University, Kolhapur
Syllabus
2025-26 Onwards

Doctor of Philosophy in Environmental Science

- **PROGRAMME OUTCOMES (PO'S)**

The Ph.D. students are able to :
PO-1) To develop an awareness and sensibility to the total environment and its allied problems.
PO-2) To develop basic understanding of the total environment, its associated problems and humanity's critically responsible presence and role in it.
PO-3) To develop attitude to social values, strong feelings of concern for the environment and motivation for active participation in its prediction and improvement.
PO-4) The develop skills for solving environmental problems.

The syllabus of the Ph. D. in Environmental Science shall have following components.

a) **Paper – I :** Research Methodology **(100 marks)**
b) **Paper – II :** Recent Advances in Environmental Science **(100 marks)**
c) **Paper – III (Optional paper) (100 marks)**
   Optional Paper I: Air Pollution and Control
   Optional Paper II: Solid Waste Management
   Optional Paper III: Water and Wastewater Treatment
   Optional Paper IV: Sustainable Environmental Management

(Note: The student has to secure minimum 40% marks to successfully complete the course work in individual head (a),(b) and (c) stated above)

- **PROGRAMME OUTCOMES (PO'S)**

The Ph.D. students are able to:
PO-1) To develop an awareness and sensibility to the total environment and its allied problems. **PO-2)** To develop basic understanding of the total environment, its associated problems and humanity's critically responsible presence and role in it.
PO-3) To develop attitude to social values, strong feelings of concern for the environment and motivation for active participation in its prediction and improvement.
PO-4) The develop skills for solving environmental problems.
PO-5) To develop evaluation ability to evaluate environmental measures and educational programmes in terms of ecological, political, economic, social, aesthetic and educational factors.

Paper – I

Research Methodology, Quantitative Techniques and Computer Application

Unit 1: Principles of scientific research and experimentation

Concept of Scientific Research: Nature and types of research; research methods, Experimental design, research process (formulation of problem, literature survey, Developing working problem, designing methodology of data collection, Analysis of Data and its presentation); Concept of good research. Need for Reviewing Literature, what to review and for what purpose, Literature Search Procedure, Sources of Literature, Planning of Review work, Note Taking, Libraries and Documentation and management of bibliography with softwares (e.g. End Note, Mendeley etc.).

Planning of Research: Selection of a Problem for Research, Formulation of the Selected Problems, Hypothesis formation, Measurements, Research Design/Plan.

Research communication: Writing review article, Research paper, Research project and Research Report and thesis.

UNIT 2: Biostatistics in Research

Processing of data: Classification and tabulation.

Data Analysis: Descriptive- Measurement of Central Tendencies, Measures of Variations, Correlation, Regression, multiple discriminant analysis (MDA), Analysis of Variance (ANOVA), Analysis of Co-Variance (ANCOVA), Multivariate analysis of variance (MANOVA), Multidimensional scaling.

Inferential- Hypothesis testing, T- tests, Chi-square test, post-hoc tests. Concept of probability.

Introduction to computer programs used for biostatistics: MS-Excel, SPSS, STATISTICA, PAST, r- statistics, PRIMER etc. Basics of Geographic Information Systems (GIS) and remote sensing, Mapping and monitoring land use and land cover changes, Habitat suitability modeling and conservation planning, Assessing ecosystem health and detecting disturbances, Monitoring climate change impacts on ecosystems

Unit 3: Introduction to Environmental Monitoring:

Principles and objectives of monitoring and sampling; Environmental Parameters: Air (gaseous and particulate matter), Water (Physico-chemical parameters, biological indicators), Soil (Contaminants)

Types of environmental samples, Sampling objectives and strategies, Sampling Techniques: Grab sampling, Composite sampling, Passive sampling etc., Sample preservation and handling, Field Sampling Protocol, Sample preparation techniques.

Unit 4: Analytical instrumentation:

Analytical instrumentation I: Principle and applications of Microscopy: Optical microscopy: Bright field and dark field, Phase contrast, Fluorescence, Confocal; Scanning electron microscopy, Transmission electron microscopy and Atomic force microscopy. Principle and applications of Chromatography: Thin layer chromatography, Gas chromatography, High performance liquid chromatography, Ion-exchange chromatography.

Analytical instrumentation II: Principle and applications of Spectroscopy: Ultraviolet-Visible spectroscopy, Atomic absorption spectroscopy, Inductively coupled plasma mass spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, Laser induced fluorescence, X-ray Fluorescence, X-ray diffraction, Photoluminescence, Nuclear magnetic resonance

Reference books :

1. Bedekar V. H. 1982 – How to write assignments, research papers, dissertations. Kanak New Delhi.
2. Barzam J. and Graff Henry, 1977- The Modern Researcher. Hercoust Brace. Javanavish Inc. 3rd Ed.
3. Gatner, E. S. M. & F. Cardasco 1970 – Research and report writing, Pb. Bernes and Noble, N. Y.
4. Gibaldi pseph & Acheert Walters, 1981 – Modern Languaga Association Hand Book for Writers of Research paper – Affiliated East West press Pvt. Ltd.
5. Gupta S. P. 1978 Science and its methodology Ajanta pb.
6. Glick D. and Reschboam R. M. 1977 – Techniques of biological and biophysical methodology, J. Wilen & Sons, London
7. Salunkhe D. K. and Bapat D. R. 1984 – Preparation and Presentation of scientific publications ph. Registrar M. P. K. V. Rahuri.

Paper II

Recent Advances in Environmental Science

Unit 1. **Trends and measure in conservations:**

Recent trends in conservation of wild life, and genetic resources, gene pool and endangered species and their conservation and protection, culturing as conservation of species, national parks and animal in captivity, socio-psychological impact on them, biochemical changes as reflected by behavioral changes of wild animals, breeding in captivity of endangered animals sperm bank.

Tissue culture measures and conservation and preservation of biodiversity in plant species, data base and recent trends of preserving endangered species, Devarais as conservation method of forests. World trends and programme in conservation of biodiversity, legislation against poaching and hunting and their implementation some word examples of national parks.

Unit 2. **Recent trends in energy studies :**

Present state, Prospects and problems alternative measures, Energy from biomes,

energy plantation, fast growing trees and environmental problems, plantation for clean environment and ecological balance, biogas, wind mills and rural energy supply, city garbage and domestic wastes and their recycling for energy and fertilizer, minihydal projects Vs major hydal projects, cost benefit ratio in terms of ecological conservation future plans, and possible means.

Unit 3. **Recent trends in organic waste conversion:**

Agricultural wastes as fertilizer and feed stuff, Brewery and distillery waste and their utilization, utilization of wastes from fermentation industry, wastes from paper factory and related cellulose wood and bark wastes as feed stuff and fertilizer. Recent trends in use of fish canning industries, trend in utilizing tannery waste. Trends of research assessment and study of movement at subsoil level in water bodies, mines and quarries agricultural practices, and fertilizer and pesticide use and their movement, chemical approach, biological approach to the problem of Genetic engineering and its application in production of microorganisms and their use in garbage decomposition.

Unit 4. **Recent trend in eco-toxicology:**

Manual and methods of studying toxicology, animal agent in toxicology, evaluation method, toxicity test, statistical concept or LD_{50}, Dose effect and dose response. Relations ships, biological and chemical factors that influence toxicity response of ecosystems to chemical stress, recent trends in study and monitoring, pollution and evolution.

References :

1. Salomons W. And Forstner U. (Ed) Environmental management of solid wastes Spinger V.
2. Bewick M. W. M. : (Ed.) Hand book of organic waste Conservation, V. N. Reinhold.
3. Levin S. A. Harwell M. A., Kelly J. R., Kuuball K. D. (Ed.) Ecotoxicology : Problems and Approach, Spinger V.
4. Bergon M. , Fitter A. H. and Mc Faybyen A. (Ed.) Advance in Ecological Research.
5. Text book of Environmental Engineering : P. Venugopala Rao, Prentice – Hall of India Pvt. Ltd. Delhi

Optional Paper: I Air Pollution and Control

Unit 1:

Air pollution: sources and types and effects on biosphere, National and international air emission standards; air pollution emission inventory; emission factor; air quality index; Strategy for effective control of air pollution in India, Introduction to air pollution control act, and international agreements for mitigating global air pollution effects.

Unit 2:

Physics of atmosphere, Solar radiation, Wind circulation, Lapse rate, Inversion, Stability conditions, Pasquil stability model, maximum mixing depth, Wind rose, Plume behavior, Global effects of air pollution: Green house effects, acid rain and ozone layer depletion, Heat island effect, Visibility, Photochemical reaction

Unit 3:

Eddy diffusion model, the Gaussian dispersion model, point source, Line source, maximum ground level concentration, Determination of stack height, sampling time corrections, Effects of inversion trap Definition, distribution and source of different particulate matter, Terminal settling velocity, basics of hood and duct design for particulate collection.

Unit 4:

Principles of absorption, Adsorption, Basic design of absorption and adsorption units Operation design and component detailing of Settling chamber, Cyclone, Wet collectors, Fabric filter, and Electrostatic precipitator ,Automobile Source Emission of pollutants from automobiles, Photochemical smog, Reduction of emissions by different methods, Alternative fuels and their utilizations

Reference books :

1. Wark and Warner, “Air Pollution”, C.F., H.R. Publication, 1st Edition, 1978.

2. Nevers N., "Air Pollution control Engineering" McGraw-Hill, New York, 2nd edition, 1995.

3. Martin Crawford, “Air Pollution and Control”, Tata McGraw Hill Publication, 1st Edition, 1976

4. Richard W. Boubel and Bruce Turner, "Fundamentals of Air Pollution", Academic Press, New York, Third edition, 1994.

5. Stern A. C., “Air Pollution Vol. I and II”, Allied Publishers Limited, 1st Edition, 1994. 6. Rao H.V.N. and Rao M. N., "Air Pollution", Tata McGraw Hill, 1st Edition, 1989

Optional Paper: II Solid Waste Management

Unit 1:

Sources, Types, Composition, Physical, Chemical and Biological properties. Solid Waste Management: Objectives, Functional elements, Environmental impact of mismanagement,: Present Indian Scenario and scope to improve system for different functional elements of solid waste management system.

Unit 2:

Solid Waste Generation Rate: Definition, Typical values for Indian cities, Factorsaffecting. Storage and collection: General considerations for waste storage at source, Collection components, Types of collection systems and its design, Transportation of solid waste: Means and methods, Routing of vehicles. Transfer station: Need, Types, factors affecting Capacity, Location and economic Viability

Unit 3:

Waste Processing Techniques: Purpose, Mechanical volume and size reduction, component separation techniques. Material Recovery and Recycling: Objectives, Recycling program elements, Commonly recycled materials and processes. Energy recovery from solid waste: Parameters affecting, Fundamentals of thermal processing, Pyrolysis, Incineration, Refuse derived fuels, Energy recovery, case studies under Indian conditions.

Unit 4:

Benefits, Processes, Stages, Technologies, Factors affecting, Properties of compost. Vermicomposting, Biomethanation , Site selection, Types, Principle, Processes, Land filling methods, Leachate and landfill gas management, Design of a landfill facility, closure, post-closure plans, and rehabilitation

of dumpsites. Waste Management legislation in India, integrated management-Public awareness; Role of NGO's; Introduction to various initiatives of the Govt. of India such as Swachh Bharat Mission, Smart Cities as well as Make in India; Biomedical; C and D waste Generation, identification, storage, collection, transport, treatment, and disposal, occupational hazards and safety measures

References:

1. Bhide. A. D. and Sundaresan. B. B., "Solid Waste Management", Indian National Scientific Documentation Centre, 1st Edition, 1983.
2. CPHEEO, "Manual on Municipal Solid waste management", Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000
3. Tchobanoglous G., "Integrated Solid Waste Management", Tata McGraw-Hill Publishing Company Limited, 1st Edition, 1993.
4. Vesilind, Worrell and Reinhart, "Solid Waste Engineering", Cengage Learning India Pvt. Ltd.,
5. Masters G., "Introduction to Environmental Engineering and Science", Pearson Education, 2004
6. Peavy, Rowe and Tchobanoglous, "Environmental Engineering", Tata McGraw-Hill Publishing Company Limited, 1st Edition, 1985.
7. "MSW Rules 2016", Swachh Bharat Mission and Smart Cities Program of India

Optional Paper: III Water and Wastewater Treatment

Unit 1: Water Quality monitoring and standards

Water Quality Standards, Potable and Palatable waters, liquid concentration units and conversions, water pollutants and their sources, Measurement of Water Quality Parameters, Organoleptic and Physicochemical Parameters, Fundamentals of Sampling and Analysis Water Sampling, Quality Control and Quality Assurance (QA/QC)

Unit 2: Water Treatment Technologies:

Coagulation and Flocculation Colloidal suspensions, coagulation and flocculation processes, stability of colloids, Destabilization of colloids, Selection of coagulants, coagulant aids, rapid mixing, transport of colloidal particles, Flocculation – shear gradients, energy requirements, Camp no.; flocculation equipment, **Sedimentation processes,** discrete particle, flocculent particles, dilute suspension, concentrated suspension, Class-1 sedimentation, Class-II sedimentation, Zone settling, Compression, Stroke's law, Newton's law, Hazen and Camp relationship, settling tank design, types of settling tanks

Filtration processes, Different types of filtration used in water treatment, filtration media, grain size distribution (effective size and uniformity coefficient), rapid and slow sand filtration, filter head loss,

backwashing, novel filtration designs, membrane Processes (Reverse Osmosis, Nanofiltration, Ultrafiltration, Microfiltration), advantages and disadvantages of reverse osmosis.

Adsorption and Ion exchange Processes Adsorption and ion exchange processes, Adsorption equilibrium, Isotherms, Freundlich and Langmuir models, ion-exchnagers (anionic and cationic) Disinfection Different approaches to disinfection and disinfectant types, disinfection kinetics (Chick's law), Break-point Chlorination, formation of Trihalomethanes

Unit 3: Biological Treatments:

conventional activated sludge process (ASP), aerated lagoon and waste stabilization ponds, Modelling aerobic suspended growth in complete-mix and plug flow reactor with and without recycle, Design and operation of sequential batch/cyclic ASP and membrane bioreactor, Biological filtration, Eckenfelder model for performance of packed tower with and without recirculation, Design and operation of rotating biological contactor.

Unit 4: Decentralized wastewater treatment systems

Design and operation of decentralized wastewater treatment systems Moving Bed Bioreactor, Anaerobic filter, Modified septic tank, Constructed Wetland (CW): Classification and application, Design and operation of horizontal flow subsurface, Vertical flow systems Emerging concepts in CW, Sludge treatment constructed wetland, Design and operation of Water hyacinth system.

References :

1. Chemistry for Environmental Engineering By Clair N. Sawyer; Perry l. McCarty; G. F. Parkin, Fifth Edition, Publisher: Tata McGraw-Hill

2. Introduction to Environmental Engineering and Science By Gilbert M. Masters, Publisher: Prentice-Hall of India Private Limited, Third Edition

3. Environmental Chemistry By Stanley E. Manahan, Publisher: Lewis Publishers

4. Wastewater Engineering: Treatment and Reuse By Metcalf and Eddy, Publisher: Tata McGraw-Hill

5. Water Chemistry by Mark Benjamin Publisher: McGraw-Hill, Publishing Co.; International edition

6. Water Chemistry by Vernon L. Snoeyink and David Jenkins, Publisher: Wiley (April 17, 1980)

7. Aquatic Chemistry (Paperback) by Werner Stumm and James J. Morgan, Publisher: Tata McGraw Hill

8. Principles of Environmental Chemistry by James E. Girard, Publisher: Jones & Bartlett Publishers

Optional Paper: IV Sustainable Environmental Management

Unit 1: Fundamentals of Environmental Management:

Interaction of Natural Environment and Human Society; Human Population growth; Concept of Carrying Capacity; Environmental Ethics; Understanding Environmental Changes at local, regional and global level. **Natural Resource Management and Conservation**: Principles of Natural Resource Management. Understanding and planning for balanced utilization of Natural Resources with special reference to Water, Land and Forest Resources. Water quality and quantity, rational distribution of water in Agriculture, Industry and Domestic sector. Land use planning and distribution at Local, Regional and National level. Forest conservation Act of India

Unit 2 : Economic Development and Environmental Degradation : Concept of Environmental Economics; Natural Resource Scarcity; Theory of Supply and Demand; Environmental Costs and Benefits; Environmental Externalities. Methods of Sustainable Economic Growth. Sustainable Development and Environmental Protection The concept of sustainable development; Dimensions of Sustainable Development, Sustainable Development Goals (SDG), Policies of Sustainable Development at Global Regional and National Level; Implications of Sustainable Development for India.

Unit 3 : Environmental Legislation Development and It's Implementation:

Indian Constitution and Environment; History of Environmental Legislation in India, Development of Environmental policies and regulations; Important Environmental Acts in India.

Unit 4: Environmental Management Tools and Techniques:

Voluntary Installation of Environmental Management System (EMS) and Life Cycle Analysis (LCA) in organizations, Origin and development of EIA, National environmental policy and statutory requirements of EIA, objectives of EIA, Methodology of EIA; categorization and evaluation criteria; prediction and assessment of impact, interaction between environmental components and impacts. Alternate strategies and mitigation measures, environmental monitoring and audit. Case studies: river projects: oil refineries and petrochemicals etc. study for major development projects. Environmental Management Plan (EMP) and Environmental Clearance. Nature of Global Environmental issues and their management. United Nations and International Environmental Agreements and treaties such as Kyoto Protocol, Montreal protocol and Paris Agreement.

References :

1) Introduction To Environment Management: M. M. Sulphey and M M Safeer,

2) Introduction to Environmental Management: I.V Murali Krishna Valli Manickam

3) Environmental Management: Vijay Kulkarni andT.V.Ramchandra

4) Environmental Management and Development: C.J Barrow