

**ST. JOSEPH'S UNIVERISTY  
BENGALURU-560 027**

**DEPARTMENT OF ENVIRONMENTAL SCIENCE  
SYLLABUS FOR UNDERGRADUATE COURSE  
ENVIRONMENTAL SCIENCE  
as per NEP – 2020**



**2022 - 2023 onwards  
ST. JOSEPH'S UNIVERSITY  
BENGALURU-560 027**

## **DEPARTMENT OF ENVIRONMENTAL SCIENCE**

### **Vision**

Empowering and emancipating students through an understanding of the environment, sustainability and related ethical issues.

### **Mission**

Our mission is to develop environmentally conscious citizens who are able to appreciate the environment in its totality. We strive to equip our students with motivation, attitude, sound knowledge, commitment and skills to actively participate, at various levels, in sustainably managing environmental issues.

## B.Sc. (Basic/Hons.) Semester 1

### ES 121 - DIVISIONS OF THE ENVIRONMENT

Number of Theory Credits	Number of lecture hours/ semester
4	52

<b>CONTENTS OF ES 121: DIVISIONS OF THE ENVIRONMENT</b>	<b>52Hrs</b>
<b>Unit - 1</b>	<b>08</b>
Environmental Education: Definition, Aim, Objectives and Scope. Environmental Science: Definition, Aim of study and Scope. Differences between Ecology and Environmental Science; Various approaches of studying Environmental Science. Components of the Environment: Definitions of Atmosphere, Hydrosphere, Lithosphere and Biosphere - their complex interactions and significance.	
<b>Unit - 2</b>	<b>16</b>
Atmosphere: Evolution of the atmosphere – Principal components – Permanent and variable gases. Structure of the atmosphere on the basis of temperature and composition. Ozone chemistry - Depletion and recovery of stratospheric ozone – monitoring, effects and control measures. Climatology: Differences between weather and climate; Insolation - Factors affecting the distribution. Solar (short-wave) and terrestrial (long-wave) radiations. Earth's Albedo and Heat budget of the earth. Tropical monsoon climate – Tropical cyclones and their impacts. Weather forecasting and modification. El-Nino and La-Nina effect. Global warming, effects and control measures; Global dimming - Definition, causes and implications; Urban Heat Islands.	
<b>Unit - 3</b>	<b>14</b>
Hydrosphere: Hydrologic cycle - process of heat energy transfer - Radiation, Conduction and Convection. Types of lifting and precipitation - Bergeron process – Cloud formation and classification. Forms of condensation; Forms of precipitation. Cloud seeding. Limnology: Definition – Lotic and Lentic environment. Differences between Lotic and Lentic systems.	

<p>Lotic environment: Springs, Stream profile: Potomom and Rhithron.</p> <p>Lentic environment: Ponds, lakes and estuaries – their types. Photic and thermal stratification of Lentic systems.</p> <p>Marine environment: Zonation, Salinity status of marine environment, biotic communities of oceanic zones, acidification of sea water; ocean currents and tides –significance; Polymetallic nodules.</p> <p>Ground water: Definition. Zonation; Types of wells. Salinization of groundwater in coastal regions.</p>	
<p><b>Unit - 4</b></p>	<p><b>14</b></p>
<p>Lithosphere: Definition. Internal structure of the earth.</p> <p>Endogenic processes: Plate Tectonics – Earthquake and Volcanism – Causes, Effects, and Management.</p> <p>Exogenic processes: River, Sand dunes, Glaciation, Avalanches and Landslides.</p> <p>Mineralogy: Definition. Outline classification of minerals</p> <p>Petrology: Definition. Classification - Igneous, Sedimentary and Metamorphic rocks – their formation – types – uses.</p> <p>Pedology: Soil – definition – formation – soil profile. Types – Alluvial; Black; Red and Laterite; Arid and Desert; Saline and Alkaline; Peaty and Marshy; Grassland, Forest and Mountain Soils. A brief account of Soil biota. Soil weathering and erosion – Types, effects and management.</p>	

## References

- Allaby, M. (2002). Basics of Environmental Science. Routledge.
- Barry, G. R. and Chorley, J. R. (2003). Atmosphere, Weather and Climate. Routledge, London.
- Critchfield, H. J. (1995). General Climatology. Printice Hall of India.
- Horne, A. J., & Goldman, C. R. (1994). Limnology (Vol. 2). New York: McGraw-Hill.
- Lutgens, F. K. and Tarbuck, E. J. (1982). Atmosphere – Introduction to Meteorology. Prentice Hall Inc.
- Manahan, S. E. (2011). Fundamentals of environmental chemistry.

CRC press.

Miller, G. T., & Spoolman, S. (2015). Environmental Science. Cengage Learning.

Miller, Jr. G. T. (1994). Living in the Environment: Principles, Connections and Solutions. Wadsworth Publishing Co.

Miller, R. W. and Donahue, R. L. (1992). Soils – Introduction to Soils and Plant Growth. Prentice Hall of India.

Mitra, A., & Chaudhuri, T. R. (2020). Basics of Environmental Science. New Central Book Agency.

Nandini, N. (2019). A text book on Environmental Studies (AECC). Sapna Book House, Bengaluru.

Wright, R. T. (2007). Environmental science: toward a sustainable future. Jones & Bartlett Publishers.

## ES 1P1: WATER QUALITY ANALYSIS

Number of Practical Credits	Number of practical hours/ semester
2	52

1. Sampling technique of water
2. Determination of pH – pH metric method
3. Determination of Electrical Conductance – Conductivity meter method
4. Estimation of Turbidity – Nephelometric method
5. TS, TSS & TDS – Gravimetric and Filtration method
6. Estimation of Acidity – Alkalimetric method / CO<sub>2</sub> – NaOH titration method
7. Estimation of Alkalinity – Acidimetric method
8. Estimation of Hardness – EDTA Complexometric method
9. Estimation of Chlorides – Argentometric method
10. Estimation of Dissolved Oxygen – Modified Winkler’s method
11. Estimation of Nitrates – Phenoldisulfonic Acid method
12. Estimation of Fluorides – Fluoride meter method/SPADNS Reagent method
13. Estimation of Sulphates – Barium chloride method

### References

Nandini, N. (2009). Handbook on water quality monitoring and Assessment.

Sapna Book House, Bengaluru.

Sawyer, C. N. and Mc Carty, P. L. (1978). Chemistry for Environmental Engineering. Mc Graw – Hill International.

Saxena M M. (1990). Environmental Analysis: Water, Soil and Air. Edition,2. Publisher, Agro Botanical Pub.

Standard Methods for Examination of Water and Wastewater. (2017). APHA – WEF.

Trivedi, P. K. and Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publication.

Zhang, C. (2007). Fundamentals of environmental sampling and analysis. John Wiley & Sons.

**ES 221 - ECOLOGY – THEORY AND PRACTICE**

Number of Theory Credits	Number of lecture hours/ semester
<b>4</b>	<b>52</b>

<b>CONTENTS OF ES 221: ECOLOGY – THEORY AND PRACTICE</b>	<b>52Hrs</b>
<b>Unit – 1</b>	<b>14</b>
<p>Levels of organization, Ecology: Divisions of Ecology - approaches in studying Ecology.</p> <p>Ecosystems – Definitions. Classification of ecosystem – Terrestrial and Aquatic with their divisions. Structure of the ecosystem - Function of ecosystem - food chain – food web – bio-magnification. Ecological pyramids – Types.</p> <p>Biogeochemical cycles: Classification. Carbon and Phosphorus cycles – anthropogenic influences on these cycles.</p> <p>Energy flow in an ecosystem – productivity - trophic levels; Study of pond and crop land ecosystems; homeostasis and feedback mechanisms.</p>	
<b>Unit – 2</b>	<b>14</b>
<p>Community Ecology: Definition, Characteristics of a Community – Species diversity, growth form and structure, dominance, relative abundance, trophic structure.</p> <p>Population Ecology: Definition, Characteristics of Population: Density – Natality – Mortality – Age distribution – Growth form-Population Equilibrium – Biotic potential – Carrying capacity – Dispersal – Dispersion – Population fluctuations – Population regulation.</p>	
<b>Unit - 3</b>	<b>14</b>
<p>Ecological succession – Primary and Secondary succession – Natural and man-influenced succession, – Hydrarch and Xerarch - Climax vegetation and their theories; Ecotone and Edge effect; Ecological equivalents; Ecotypes and Ecophenes; Ecological indicators.</p> <p>Ecological Niche: Concept and Types of niches: Spatial, Trophic and Multidimensional – Niche parameters: Form, Position and Width – Niche Partitioning - Realized and Fundamental Niche.</p>	

Biomes: Definition and concept. Classification of biomes.	
<b>Unit - 4</b>	<b>14</b>
<p>Biotic and Abiotic factors: Influence Temperature, Wind and Water, Edaphic, Topographic on flora and fauna.</p> <p>Concept of Limiting Factors: Liebig's Law of Minimum; Shelford's Law of Tolerance and the combined concept.</p> <p>Evolution: Definition – Darwin's postulates - Natural selection – Types –</p> <p>Industrial Melanism - Pesticide resistance.</p> <p>Co-evolution; Mimicry – Batesian and Mullerian mimicry, warning colouration.</p>	

### References

Agarwal, K. C. (1999). Environmental Biology. Agro Botanica.

Beck, W. S., Liem, K. F. and Simpson, G. G. (1991). Life – Introduction to Biology. Harper Collins Publications.

Chapman, J. L. and Reiss, M. J. (1995). Ecology – Principles and Applications. Cambridge University Press.

Dash, M. C. (2001). Fundamentals of Ecology. Tata McGraw-Hill Publishing Co. Kormondy, E. J. (1996). Concepts of Ecology. Prentice Hall of India.

Mamta Rawat, Sumit Dookia and Chandrakasan Sivaperuman. (2015). Aquatic Ecosystem: Biodiversity, Ecology and Conservation. Springer publication.

McCleery, Robert A., Moorman, Christopher, Peterson, M. Nils (Eds.). (2014).

Urban Wildlife Conservation - Theory and Practice. Springer publication.

Odum, E. P. (1971). Fundamentals of Ecology. W.B. Saunders Co.

Raven, P. H. and Johnson, G. B. (1995). Biology. Wm. C. Brown

Publications.

Ricklefs, R. E. and Miller, (1999). Ecology. W.H. Freeman and Co.

Smith, T. M. and Smith, R. L. (2007). Elements of Ecology. Pearson Education.

Taylor, T. J., Green, N. P. O. and Stout, G.W. (1998). Biological Science

Soper, R.(ed.). Cambridge University Press.

Wallace, R. A. (1990). Biology – The World of Life. Harper Collins Publications.

## ES 2P1: ECOLOGICAL ANALYSIS

Number of Practical Credits	Number of practical hours/ semester
2	52

1. Sampling technique of phytoplankton
2. Sampling technique of zooplankton
3. Quantitative estimation of phytoplankton – Sedgwick-Rafter method
4. Quantitative estimation of zooplankton – Sedgwick-Rafter method
5. Determination of organic pollution – Palmer’s Algal Pollution index
6. Estimation of primary productivity of a pond – Light and Dark bottle method
7. Estimation of primary productivity of terrestrial vegetation – Chlorophyll method
8. Estimation of primary productivity of grasses – Harvest method
9. Study of plant community – Individual count method/Quadrat method
10. Study of animal community – Line transect method
11. Determination of species diversity indices –Simpson and Shannon's Wiener Index
12. Estimation of carbon capture and storage of trees
13. Identification of ecological indicators

### References

Michael, P. (1986). Ecological Methods for Field and Laboratory Investigations.  
Tata Mc Graw-Hill Publishing Co. Ltd.

Rolan, R. G. (1973). Laboratory and Field Investigations in General Ecology.  
Macmillan Co.

Standard Method for Examination of Water and Wastewater.  
(2017). APHA –WEF.

Subrahmanyam, N. S. and Sambamurty, A. V. S. S. (2000).  
Ecology. Narosa Publishing House.

Trivedi, P. K. and Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publications.

### B.Sc. (Basic/Hons.) Semester 3

#### ES 322 –ENVIRONMENTAL MICROBIOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY

Number of Theory Credits	Number of lecture hours/ semester
4	52

<b>CONTENTS OF ES 322: ENVIRONMENTAL MICROBIOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY</b>	<b>52Hrs</b>
<b>Unit – 1</b>	<b>11</b>
<p>Environmental Microbiology: Definition, scope, Microbial Biodiversity, Phylogenetic tree, Prokaryotes and Eukaryotes, Whittaker’s five Kingdom concept. Major characteristics of microorganisms – <i>morphological, chemical, cultural, metabolic, genetic, antigenic, ecological and pathogenicity.</i></p> <p>Environmental determinants: Definition – pH, Temperature, Radiation, Pressure and Salinity; Adaptations of micro-organisms to environmental extremes.</p> <p>Microbial Symbiosis: positive and negative interactions: Mutualism, Commensalism, Amensalism, Antagonism and Competition.</p>	
<b>Unit – 2</b>	<b>18</b>
<p>Air Microbiology: Definition. Airborne Infections – Causative Microbes – Control Measures; Sick Building Syndrome; Droplet infection.</p> <p>Aquatic Microbiology: Definition. Waterborne Diseases. Disinfection of water for potable purposes. Definition, sources and causes of Biofouling, Biofilms and Bio-corrosion.</p> <p>Role of microbes in waste water management: Activated Sludge Process, Oxidation Ponds, Oxidation Ditches, Trickle Filters, Up-flow Anaerobic Sludge Blankets, Septic Tanks.</p>	

<b>Unit – 3</b>	<b>10</b>
Soil Microbiology: Definition. Rhizosphere and Rhizoplane Microflora –Biodegradation of DDT, PCBs and Plastics; Bioleaching of Heavy Metals – Copper, Iron and Uranium; Role of microbes in Biogeochemical Cycles: Nitrogen, Phosphorus and Sulphur; Composting.	
<b>Unit – 4</b>	<b>13</b>
Bioremediation of Xenobiotic Pollutants: Testing for Effects on Microorganisms – Bioremediation Efficacy Testing – Side Effect Testing. Approaches to Bioremediation: Environmental Modification and Microbial Seeding –Bioremediation: Contaminated Soils, Aquifers, Marine Oil slick and Air Pollutants; Biosensors. Genetically Engineered Species and Pest Control; Biotechnology and	

## References

- Agarwal, S. K. 1998. Environmental Biotechnology. APH Publishing Corporation.
- Atlas, R. M. and Bartha, R. 1998. Microbial Ecology – Fundamentals and Applications. Benjamin/Cummings Science Publishing.
- Baker, K. H. and Herson, D. S. 1994. Bioremediation. McGraw-Hill Inc.
- Bitton, G. 1994. Wastewater Microbiology. Wiley-Liss Inc.
- Chatterji, A. K. 2002. Introduction to Environmental Biotechnology. Prentice-Hall of India Pvt. Ltd.
- Forester, C. F. 1985. Biotechnology and Wastewater Treatment. Cambridge University Press.
- Herren R. V. (2005). Introduction to Biotechnology – An agricultural Revolution. Thompson Delmar. New York.
- McCarty, P. L. 2001. Environmental Biotechnology: Principles and Applications. McGraw Hill International Editions.
- Mitchel, R. (Ed.) 1992. Environmental Microbiology. Wiley-Liss Inc.
- Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. 1993. Microbiology – Concepts and Applications. McGraw-Hill Book Co.
- Southey, C., Kaushik, N. and Trivedi, R. K. (Eds). 2001. Detergents and the Environment. Tata McGraw-Hill Publishing Co. Ltd.
- Sharma, P. D. (2016). Microbiology. Rastogi Publications, Meeret
- Thakur, I. S. 2006. Environmental Biotechnology: Basic Concepts and Applications. I. K. International Pvt. Ltd.

**ES 3P1: ENVIRONMENTAL MICROBIOLOGY  
AND ENVIRONMENTAL BIOTECHNOLOGY**

Number of Practical Credits	Number of practical hours/ semesters
<b>2</b>	<b>52</b>

1. Isolation of Bacteria from Water/Wastewater – Serial Dilution Technique.
2. Identification of Bacteria – Gram Staining.
3. Isolation of Fungi from Soils – Pour Plate method.
4. Identification of Fungi – Lactophenol Cotton Blue Staining.
5. Construction of bacterial growth curve – pH – Broth culture
6. Minimum Inhibitory Concentrations (MICs) of Heavy metals on bacteria – Mueller-Hinton Agar method
7. Study of Root Nodule Bacteria – Gram Staining.
8. Study of Endomycorrhiza (VAM), Coralloid roots and Lichens.
9. Estimation of Coliform Group of Bacteria – MPN Technique.
10. Estimation of Coliform Group of Bacteria – MF Technique.

**References**

Aneja, K. R. 1996. Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation. Wishwa Prakashan.

Benson, H. J. 1998. Microbiological Applications – Laboratory Manual in General Microbiology. McGraw-Hill Publications.

Bhattacharyya, B. N. 1993. Experiments with Microorganisms. Emkay Publications.

Standard Method for Examination of Water and Wastewater. 2012.  
APHA – WEF

**B.Sc. (Basic/Hons.) Semester 4****ES 422- NATURAL RESOURCES AND MANAGEMENT**

Number of Theory Credits	Number of lecture hours/ semester
<b>4</b>	<b>52</b>

<b>CONTENTS OF ES 421: NATURAL RESOURCES AND MANAGEMENT</b>	<b>52Hrs</b>
<b>Unit – 1</b>	<b>17</b>
<p>Natural Resources: Definition, Characteristics of Natural Resources. Classification of natural resources based on utility potential. The Phantom pile concept; Jeavon’s paradox – Environmental Rebound effect – Khazzoom Brookes postulates.</p> <p>Water Resources:</p> <p>Surface water -Water budget of India - Droughts and Floods: Causes and Control Strategies – Watershed Management; Dams: Impact on environment – alternatives; Rain Water Harvesting and ground water recharge; River linking.</p> <p>Ground water: Impacts of urbanization, industrialisation and agriculture on ground water.</p> <p>Marine water – Ocean as a resource</p> <p>– Marine ranching: fisheries, aquaculture – oysters</p> <p>Transportation – Shipping (people, goods and oil) and its impacts</p> <p>Desalinisation; Salt pans; Coastal erosion and reclamation; Coastal Regulatory Zones</p> <p>Estuaries – prawn culture and its impacts</p>	
<b>Unit – 2</b>	<b>9</b>
<p>Land resources in India: Land-use patterns in India. Ownership patterns and conflicts. Agriculture – Types and cropping patterns – Soil erosion – causes, types, impacts, control measures. Desertification: causes, impacts and control measures.</p>	
<b>Unit – 3</b>	<b>13</b>
<p>Forest Resources: Importance of Forestry – Types of Forests of India and Karnataka – Pressures on forest areas – encroachments, forest fires, land use change (allocation for agriculture, industry and housing)</p>	

and over utilisation of forest resources (harvesting of NTFPs, overgrazing, other anthropogenic pressures).	
<p>Impacts of Deforestation: - Forest Fires and their Control; Forest conservation: Sacred Groves; Chipko and Appiko Movements; Joint Forest Management; Afforestation and Reforestation, Major and Minor Forest Products; Forest based industries (Plywood, Pulp and Paper and Cottage industries)</p> <p>Ecotourism and its impacts.</p> <p>Captive plantations and Energy plantations</p> <p>Forest and wildlife conservation - Protected areas – Sanctuaries - National Parks – Biosphere Reserves.</p>	
<b>Unit – 4</b>	<b>13</b>
<p>Energy Resources: Definition - Classification of energy resources; Conventional, non-conventional and alternative energy resources.</p> <p>Energy sources and their impacts: Biomass burning (Fuelwood, Agriculture residue, Cow dung), Fossil fuels, Hydel, Geothermal, Nuclear energy; Solar (Thermal and Photovoltaic), Wind, Tidal, Micro-hydel. Briquettes, Wood gas, Energy from waste (Pyrolysis and Biogas), Agrofuels and Bioenergy (<i>Biodiesel, Gasohal, M 15 Petrol</i>), Hydrogen fuels.</p> <p>Mineral resources: Mining and Quarrying and their impacts; Ecological conflicts of mineral extraction; Deep-sea mining – Polymetallic nodules and off shore oil exploration, Hydrocarbon projects in the Kaveri basin and their impacts.</p>	

## References

Abbasi, S. A. and Abbasi, N. 2001. Renewable Energy Sources and their Environmental Impact. Prentice-Hall of India Pvt. Ltd.

Agarwala, V. P. 1985. Forests in India – Environmental and Production

Frontiers. Oxford and IBH Publishing Co.

Beck, W.S., Liem, K. F. and Simpson, G. G. 1991. Life – Introduction to Biology. Harper Collins Publications.

Dayal, M. 1989. Renewable energy – Environment and Development Konark Publishers.

Fernandes, W., Menon, G. and Viegas, P. 1988. Forest Environment and Tribal Economy. Indian Social Institute.

Gadgil Madhav and Seshagirirao, P. R. 1998. Nurturing Biodiversity - An Indian Agenda. CEE Publ. Ahmedabad.

Goel, R. S. (Ed). 1993. Environmental impacts of water resources. Tata Mc Graw Hill Publishing Co.

Gupta, R. K., Dabral, B. G., Homji, V. M. M. and Puri, G. S. 2000. Forest Ecology. Vol. 3. Oxford and IBH Publishing Co.

ICAR. 1992. Handbook of Agriculture.

Kumar, U and Asija, M. J. 2003. Biodiversity, Principles and Conservation Agrobios (India).

Owen, O. S. 1980. Natural Resources Conservation – An Ecological Approach. Mcmillan Publishing Co. Inc.

Rao, S. M. 1990. Introduction to Social Forestry. Oxford and IBH Publishing Co.

Ristinen, R. A. and Kraushaar, J. J. 1999. Energy and the Environment. John Wiley and Sons Inc.

Santra, S. C. 2001. Environmental Science. Ist Ed., New Central Book Agency. Kolkata.

Sharma, V. K. 1985. Water Resource Planning and Management. Himalaya Publishing House. Bombay.

Singh, V. P. (2004). Tropical Forest Ecosystems – Structure and Function. Scientific Publishers, Jodhpur.

Subrahamanyam, N. S. and Sambamurthy, A. V. S. S. 2000. Ecology. Narosa Publishing House.

Trivedi, P. R. and Raj, G. 1992. Environmental Energy Resources. Akashdeep Publishing House.

Varma, A. and Behera, B. 2003. Green Energy – Biomass Processing and Technology. Capital Publishing Co.

Wallace, R. A. 1990. Biology – The World of Life. Harper Collins Publications.

## **ES 4P1: BASICS OF MAPS; IDENTIFICATION OF NATURAL RESOURCES**

Number of Practical Credits	Number of practical hours/ semester
<b>2</b>	<b>52</b>

1. Identification properties of Minerals.
2. Description of major rock forming Minerals.
3. Identification properties of Rocks
4. Description of Rocks.
5. Identification of medicinal plants of Karnataka.
6. Identification of endangered flora and fauna of India.
7. Introduction to Mapping.
8. Properties of Maps
  - i. Direction and Scale
  - ii. Latitude & Longitude
  - iii. Grid References
  - iv. Conventional signs and symbols.
9. Representation of Relief.
10. Study of Drainage pattern and Settlement pattern.

### **References**

- Ahuja, J. S., Virk, M. J. S., 1993. Map Education. Survey of India.
- Ramakrishna, T. L. 1998. Mineral Rock Guide of Karnataka. Bharat Geo Guides Publ. Bangalore.
- Ramakrishna, T. L. 1998. Manual of Rocks, Minerals and Ores of Karnataka. Bharat Geo Guides Publ. Bangalore.
- Sathyanarayanswami, B. S. 1985. Engineering Geology – Laboratory Manual. Eurasia Publishing House Pvt. Ltd.



Date:  
Registration number:

**ST. JOSEPH'S UNIVERSITY, BENGALURU-27**  
**B.Sc. ENVIRONMENTAL SCIENCE**  
**SEMESTER EXAMINATION: April / October 20\_\_**  
**ES – Paper Code and Title**

**(ALL THE THEORY PAPERS OF ALL SEMESTERS OF I, II III AND IV YEARS)**

**Time- 2 Hours**

**Max**

**Marks-60**

**This question paper comprises of 3 parts and \_\_\_\_\_ printed pages**

**Instruction: Draw diagrams wherever necessary**

**PART – A**

**Answer any SIX of the following**

**10q X 2m = 20**

1. q
2. q
3. q
4. q
5. q
6. q
7. q
8. q.
9. q
10. q
11. q
12. q

- ✓ Questions in this section are of the definition or very short answer type
- ✓ These are to be answered in two or three sentences
- ✓ Two related definitions can be part of the same question

- ✓ Simple Diagrams, equations and flow charts can be answers

### PART - B

Write explanatory notes on any **FOUR** of the following

4q X 5m = 20

13. q
14. q
15. q
16. q
17. q
18. q

- ✓ Questions in this section will be in the form of phrases, statements, comparisons or differences (Do not end with a ?)
- ✓ These are to be answered in about four paragraphs (250 – 300 words)
- ✓ Diagrams, equations and flow charts may be a part of the answers
- ✓ At least two questions are to be of the logical / analytical type.

### PART – C

Answer **ALL** the questions

2q X 10m = 20

19. a. q

**OR**

- b. q

20. a. q

**OR**

- b. q

- ✓ Questions in this section will be of the descriptive / explanatory / Comparative / analytical type.
- ✓ These are to be answered in about eight - ten paragraphs (750 – 1000 words)
- ✓ Diagrams, equations and flow charts may be a part of the answers
- ✓ Each question has two choices. The student can answer either of the choices. Choice #1 of each question can be a single question for 10 marks.

Choice #2 of each question is to have two parts. The first part may be similar to the Choice #1. The second part is to address a current / contemporary issue or a critical view point or a

mathematical calculation. The marks allotted for each part is to be specified (Ex.  $5+5 = 10$  or  $4+6 =10$ )

