UNIVERSITY OF MUMBAI
No. UG/75of 2015-16

CIRCULAR:-

A reference is invited to the Syllabi relating to the B.Sc. degree program, **vide** this office Circular No. UG/260 of 2011, dated 18th August, 2011 and the Principals of affiliated Colleges in Science are hereby informed that the recommendation made by the Faculty of Science at its meeting held on 22nd June, 2015 has been accepted by the Academic Council at its meeting held on 26th June, 2015 **vide** item No. 4.8 and that in accordance therewith, the revised syllabus as per Credit Based Semester and Grading System for the First Year (Sem. I & Sem. II) of B.Sc. program in Nautical Science, which is available on the University's web site (www.mu.ac.in) and that the same has been brought into force with effect from the academic year 2015-16.

-sd-
REGISTRAR

MUMBAI – 400 032
15th September, 2015

To,

The Principals of affiliated Colleges in Science.

A.C/4.8/26/06/2015

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No. UG/75-A of 2015-16 MUMBAI-400 032 15th September, 2015

Copy forwarded with compliments for information to :-

1)The Dean, Faculty of Science.
2) The Director, Board of Colleges and University Development,
3) The Professor-cum-Director, Institute of Distance an Open Learning (IDOL),
4) The Controller of Examinations,
5) The Co-Ordinator, University Computerization Centre.

19/9/15
REGISTRAR

..PTO

UNIVERSITY OF MUMBAI

Syllabus for the F.Y.B.Sc.
Program: B.Sc.
Course : Nautical Science

(Credit Based Semester and Grading System with effect from the academic year 2015–2016)

REGULATIONS ADDED & AMMENDED

R.8406 A candidate has to secure minimum marks/grades in each course head as described in Training Circular No 4 of 2005 by DG Shipping and adhere to guidelines of Training Circular No 4 of 2005 by DG Shipping , Govt Of India to get sea time remission of 2 years to appear for Second Mate (FG) course , which is also mentioned in Examination scheme of each course .

R.8407 ALLOWED TO KEEP TERMS (ATKT):

i) A student shall be allowed to keep term for Semester II irrespective of grades obtained in each course of Semester I.

ii) A student shall be allowed to keep term for Semester III if

He/she passes (grade 'E' or above in each course) each of Semester I and Semester II OR

He/she fails in not more than three courses of Semester I and Semester II taken together.

iii) A student shall be allowed to keep term for Semester IV irrespective of grades obtained in each course of Semester III.

However student has to pass either of Semester I or Semester II in order to appear for Semester IV

iv) A student shall be allowed to keep term for Semester V if

He/she passes Semester I, Semester II, Semester III and Semester IV OR

He/she has passed Semester I and Semester II and fails in not more than three courses of Semester III and Semester IV taken together

OR

He/she has passed Semester III and Semester IV and fails in not more than three courses of Semester I and Semester II taken together

v) A student shall be allowed to keep terms for Semester VI irrespective of grades obtained in each course of Semester V.

vi) The result of Semester VI shall be kept in abeyance until the student passes each of Semester I, Semester II, Semester III, Semester IV and Semester V.

Candidate had to clear all his/her course/s within six years from the year of his/her admission in the program to be eligible for award of the degree

R.8408 FEES :

As approved by DG Shipping vide DGS Order no.2 of 2007

P R E A M B L E

This course is an integral part of the overall planned and shipboard structured training programme for the prospective navigating officer. The course is residential in nature and of Three-year duration comprising of six semesters of six months each.

The prospective navigating officer will be trained for one year onboard ship in practical application of the theory learnt. Thereafter at the end of this structured programme, a "contact programme" for four months may be conducted at the Institute to prepare the Cadets for an oral examination conducted by the Director General of Shipping, Ministry of Surface Transport, Government of India.

On successful conclusion of the Programme a Cadet will be awarded a degree of BSc (Nautical Science) by University of Mumbai and a Certificate of Competency by Govt. of India, which will enable him to become an officer on a merchant ship.

A Pre-Sea Navigating Officer Cadet successfully completing the three year programme would acquire basic knowledge and understanding of the types of merchant ships, ship operations, types of goods carried by ships, shipping trade, and a foundation in the basic principles of navigation and environmental science.
The course is designed to impart:

~ Theory and practice of seamanship and ship knowledge.
~ Good foundation in principles of navigation and introduction to Astronomical Navigation.
~ Practical knowledge of chart work and cargo work.
~ Detailed study of atmosphere and use of meteorological instruments in connection with weather reporting.
~ Knowledge of ship construction and ship stability.
~ Regular practice in Morse code signalling, in addition to International Code of Signals and use of VHF and R/T.
~ Practical training in handling a lifeboat and motorboat.
~ One Project related to shipping industry to be under taken.
~ Study of environmental protection with reference to MARPOL 73/78.
~ Study of various IMO courses.
~ Study of basic Marine Engineering and drawing.
~ Practical Training in carpentry shop, plumbing shop, machine shop, electrical shop and maintenance workshop including Electric Arc welding and Gas welding, Hydraulics, Pneumatics and Diesel Engine maintenance .

Objective

This course is designed to assist a prospective navigating officer in achieving the minimum standards of competence for officers in charge of navigational watch on ships of 500 gross tonnes or more as specified in Regulation II/1, Table A-1 of STCW Code 2010. The course is residential in nature and its duration is 36 weeks.

This course is aimed at preparing the Cadet to develop a right attitude towards tasks and duties assigned to him during the on-board training programme in learning the job of being a ship's officer and in achieving the overall standard of competence required.

Salient features

- As under the preview of D.G Shipping, it's a fully residential course
- Students' daily routine starts from 6:00 o'clock in the morning till 8:30 in the evening, as per the requirement on board ships
- Morning exercise, parade, evening sports and 2 hours of self study classes 6 days a week is the part of daily routine.
- Trekking, dock visits, ship visits is a part of curriculum apart from other extracurricular and sports activities

Note:

The conduct of STCW 2010 courses is strictly conducted as per the guidelines of D.G Shipping; who in turn being directed by International Maritime Organization, these guidelines may be modified/ changed time to time and instructed by D.G Shipping through its training circulars or as the case may be.

B.Sc. in Nautical Science

Theory/Practical : 16 Weeks (15 weeks for lectures/practical & one week for semester end examination)

Semester –I

B.Sc in Nautical Science Theory / Practical :

Course Code	Title of the Course	Per Week		Per Semester		Credits		Total
		L	**P**	**L**	**P**	**L**	**P**	
USNSc101	English & Communication Skills	3	1	45	15	4	2	6
	Applied Mathematics-I	6		90				
	Nautical Physics & Electronics-I	4	2	60	30			
USNSc102	Navigation –I	3	1	45	15	3	2	5
	Voyage Planning & Collision Prevention – I	2	2	30	30			
USNSc103	Ship Operation Technology-I	3	1	45	15	3	2	5
	Cargo Work & Marine Communication	3	1	45	15			
	Naval Architecture-I	3		45				
USNSc104	Environmental Science-I	3	1	45	15	2	2	4
	Marine Engineering & Control Systems-I	3	1	45	15			
Total		33	10	495	150	12	8	20

Semester –II

Theory / Practical :								
Course Code	Title Of The Course	Per Week		Per Semester		Credits		Total
		L	**P**	**L**	**P**	**L**	**P**	
USNSc201	English & Communication Skills	3	1	45	15	3	2	5
	Applied Mathematics-II	6		90				
	Nautical Physics & Electronics - II	4	2	60	30			
USNSc202	Navigation –I	3	1	45	15	3	3	6
	Voyage Planning & Collision Prevention – I	2	2	30	30			
	Marine Engineering & Control Systems - II	3	1	45	15			
USNSc203	Ship Operation Technology-I	3	1	45	15	3	2	5
	Cargo Work & Marine Communication	3	1	45	15			
	Naval Architecture-I	3		45				
USNSc204	Environmental Studies	3	1	45	5	2	2	4
		33	10	495	140	11	9	20

ENGLISH & COMMUNICATION SKILLS /PHYSICS /MATHS

Contact Hours 195

Name of the Programme	**Duration**	**Semester**	**Course/ Course Code**
B.Sc in Nautical Science	Six Semesters	I	English / Physics/Maths [USNSC 101]
Course Code	Title	Credits	
USNSC 101	English/Physics/Maths	4+2	

For Course per week 1 lecture/period is 60 minutes duration				**For subject** per week 1 lecture/period is 60 minutes duration			
	Theory	Practical	Tutorial	English	Maths	Physics	
Actual contacts	13	3	--	3	6	4	
Credits	4	2	--	1		2	

NAVIGATION –I

VOYAGE PLANNING & COLLISION PREVENTION - I

Contact Hours 62

Name of the Programme	Duration	Semester	Course/ Course Code
B.Sc in Nautical Science	Six Semesters	I	Navigation-1 Voyage Planning & Collision Prevention [USNSC 102]
Course Code	Title	Credits	
USNSC 102	Navigation-1 Voyage Planning & Collision Prevention	3+2	

For Course per week 1 lecture/period is 60 minutes duration				For subject per week 1 lecture/period is 60 minutes duration	
	Theory	Practical	Tutorial	Navigation-I	Voyage Planning & Collision Prevention
Actual contacts	5	3	--	3	2
Credits	3	2	--	1	2

SHIP OPERATION TECHNOLOGY PAPER- I
CARGO WORK & MARINE COMMUNUCATION

NAVAL ARCHITECTURE-I **Contact Hours 135**

Name of the Programme	**Duration**	**Semester**	**Course/ Course Code**
B.Sc in Nautical Science	Six Semesters	I	Ship Operation Technology Paper- I Cargo Work & Communication Naval Architecture [USNSC 103]
Course Code	Title	Credits	
USNSC 103	Ship Operation Technology Paper- I Cargo Work & Communication Naval Architecture	3+2	

For Course per week 1 lecture/period is 60 minutes duration				**For subject** per week 1 lecture/period is 60 minutes duration			
	Theory	Practical	Tutorial	SOT Paper- I	Cargo Work & Comm.	Naval Architecture Paper- I	
Actual contacts	09	2	--	3	3	3	
Credits	3	2	--	1	1	-	

ENVIRONMENTAL SCIENCE-I

MARINE ENGINEERING & CONTROL SYSTEMS-I **Contact Hours 90**

Name of the Programme	Duration	Semester	Course/ Course Code
B.Sc in Nautical Science	Six Semesters	I	Environment Science – I Marine Engineering & Control System- I [USNSC 104]
Course Code	Title	Credits	
USNSC 104	Environment Science – I Marine Engineering & Control System- I	2+2	

For Course per week 1 lecture/period is 60 minutes duration				**For subject** per week 1 lecture/period is 60 minutes duration		
	Theory	Practical	Tutorial	Environment Science – I	Marine Engineering & Control System-I	
Actual Contacts	06	02	--	3	3	
Credits	02	02	--	1	1	

Objective:-

This subject exposes the students to English & Communication skills, Applied Mathematics & Nautical Physics

Contents of syllabus for USNSC 101

ENGLISH

		Theory	Practical
UNIT I	**SEMESTER - I** 1. Comprehension a) Seen and unseen comprehension. b) SMCP phrases and maritime English. c) Grammar - Sentence structures, tenses, direct and indirect speech, active and passive voice. d) Importance of effective communication.	**10 Hours**	-
UNIT II	2. Written Communication a) Formal and ordinary letters, formal invitations, letters to friends and relatives. b) Official and semi–official letters. Application for appointment. Commercial letters. Letter to influence public opinion. c) General procedures – Safety signals, standard organizational phrases, ambiguous words d) Essay writing. e) Phonology - Pronunciation, syllable stress, consonant and vowel sounds.	**22 Hours**	
UNIT III	3. Skills of oral communication a) Presentation skills – Group activities b) Asking for and giving personal data c) Expressing personal likes and dislikes, preferences d) describe crew roles and routines e) Sea speak	**5 Hours**	
	PRACTICAL All items under skills of oral communication, i.e. item 3 under course content.		**12 Hours**

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 40 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India.

Reference Books:-

Communication skills (Book 1)	S.R. Inthira & V. Saraswati
Communication skills workbook	S.R. Inthira & V. Saraswati
Spoken English for India	R.K. Bansal & B. Harrison

BOOKS RECOMMENDED FOR REFERENCE

English language Books 1 and 2	L.A. Hill, C.J. Daswani & C.T. Daswani (Oxford University Press 1975)
Written Communication	Freeman and Sarah
Note marking and composition exercises 1979	ELT Cell, Bombay University

Business correspondence and writing report	R.C. Sharma and Krishnamohan
Academic skills	CIEFL, Hyderabad
Academic skills workbook	CIEFL, Hyderabad
Supplimentry reader	CIEFL, Hyderabad
Sea speak manual	International Maritime Organisation.

APPLIED MATHS

		Theory	Practical
UNIT I	**SEMESTER – I** 1. **Complex Variables & Vector Algebra and Calculus** Definition, Cartesian, Polar & exponential form. De-Moivre's Theorem. Power & Roots of Exponential and Trigonometric Functions. Hyperbolic & Logarithmic Functions. Inverse Hyperbolic & Inverse Trigonometric Functions. Separation into real and imaginary parts of all functions. Scalar and Vector Triple Products. Differentiation of a vector function of a single scalar variable Derivative of a unit vector, application to curves in space, principal triad, Sennet-Frenet form.	**30 Hours**	**-**
UNIT II	2. **Vector Analysis & Nth Derivative** Line integral, Green's theorem for the plane, properties of line integrals, line integrals in space and their properties, application to work and to the flow of liquid, scalar and vector fields, conservative fields, potentials, gradient, divergence and curl, Divergence theorem, Stoke's theorem expressions for gradient, divergence and cut in orthogonal curvilinear co-ordinates, Gauss theorem, equation of heat flow, equations of hydrodynamic. Successive differentiation. Standard form to find the nth derivative. Leibnitz's theorem, Rolle's theorem (with proof), Lagrange's and Cauchy's mean value theorem (with proof), Taylor's theorem, Taylor's and Maclaurin's series (without proof).	**20 Hours**	
UNIT III	3. **Differential Calculus & Differential equations** Indeterminate forms. L'Hospital's rule, Expansion of function in power series (all types), Partial derivatives of first and higher orders. Total differential, Concept of commutativity of partial derivatives (without proof). Euler's theorem on homogeneous functions. Deduction from Euler theorems. Errors & approximations. Maxima & Minima the functions of two variables. a) Exact differential equations and those which can be made exact by use integrating factors by inspection. (i) Linear Equations and reducible to linear (Bernoulli) equations, (ii) Method of substitution to reduce the equations to one of the above forms. b) Linear Differential Equations of the nth order with constant coefficients. Complimentary function and Particular integral when the function of the independent variable R.H.S. is e^{ax}, x^n, $e^{ax}V(x)$, Sin (ax+b), Cos (ax+b). Cauchy's Linear equation (homogeneous). Legendre's Linear equation Variation of parameters and method of indeterminate coefficients. c) Elementary applications of above differential equations in solving engineering problems such as Electrical Engg., Mech. Engg.	**50 hours**	

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

NOTE : A candidate has to secure minimum percentage /grade : 40 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

BOOKS RECOMMENDED FOR REFERENCE:

1. Elements of applied mathematics Vol. I	Wartikar, P.N. & Wartikar, J.N.
2. Text book of applied mathematics Vol. II	Wartikar, P.N. & Wartikar, J.N.
3. Vector Algebra	Shanti Narayan
4. Vector Calculus	Shanti Narayan
5. Differential Calculus	Shanti Narayan
6. Engineering Mathematics	Bali, Saxen, Iyengar
7. Plane Trigonometry (Part II)	Loney, S.L.
8. Higher Engineering Mathematics	Grewal, B. S.
9. Differential Equations	Raisinghania
10. Engineering Mathematics	Bhatia, M. L.
11. Engineering Mathematics	Baphana, R. M.
12. Vector Methods and Vector Calculus	Vaishista
13. Differential equations	Murray P.A

NAUTICAL PHYSICS

		Theory	Practical
UNIT I	**SEMESTER – I** 1. MECHANICS: Review of Newton's Law of motion. Circular motion, Centripetal and Centrifugal forces. Law of Gravitation, Work, Power and Energy, Potential and Kinetic Energy. Conservation of Energy, Conservation of linear momentum, Impulse, collision – direct and oblique impact. Centre of Mass and Centre of Gravity, Rotational Motion, Torque, Angular Momentum, conservation of angular momentum. Hydrostatics:- Archimedes Principle, upthrust, Buoyancy, Pressure at a depth. Atmospheric Pressure, Barometer. Hydrodynamics: - Streamlines, Turbulence, Pascal Law. Bernoulli's equation: - Stability and Spin, Aerofoil, lift, Rotating cylinder ship. Surface Tension: - Capillarity, Angle of contact, Excess Pressure inside a bubble, Air bubbles in an oil tank. Oscillation: - S.H.M and its features, Typical examples – A helical spring, a pendulum. Damped & undamped oscillations, Forced oscillations (vibrations), Resonance.	**20 Hours**	**-**
UNIT II	2. SOUND & LIGHTS Velocity of sound, Effect of pressure, temperature and humidity on velocity of sound, Pitch, Quality & Loudness, The Decibel. Doppler Effect. Refraction of sound waves, Effect of wind & Temperature. Propagation of light, Shadows, Eclipses, Reflection of light at plane and curved surfaces, Rotation of a plane mirror, Refraction. Total internal reflection. Mirages. Optical fibre, the azimuth mirror, Periscope. Lenses, Image formation Telescope, Prism Binocular.	**35 Hours**	

UNIT III	3. HEAT AND THERMODYNAMICS: - Transfer of Heat: Conduction, Convection and Radiation. Expansion of solids, liquids and gases and their effect on liquid cargoes. Equation of state for gases, isothermal and adiabatic processes. First law of Thermodynamics, Second law of Thermodynamics – Carnot cycle. The Heat engine and refrigerator. **EXPERIMENTS** 1. Demonstration of block and tackle arrangements. 2. Demonstration of a Weston Differential pulley. 3. A single cantilever (loaded at one end). Determination of Y. 4. Surface tension of liquid by capillary rise method. 5. Moment of Inertia of Flywheel and Frictional Torque. 6. Velocity of sound in air (Using a CRO). 7. Use of CRO to study the characteristics of an audio oscillator (Frequency, Period, Amplitude). 8. Study of Laser: Interference and diffraction due to a single and double slit. 9. Stefan's Law of radiation using a filament lamp. 10. Thermistor as a Thermometer. **NOTE:** A minimum of 8 experiments are expected to be performed	**20 hours**	**25 Hours**

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 40 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India.

BOOKS RECOMMENDED FOR REFERENCE:-

1. Applied Physics J.H. Clough – Smith Brown, Sons & Ferguson Ltd
2. Fundamental of Physics M. Nelkon Hart–Davis Educational
3. Principles of Physics Fredrick. J. Bueche McGraw–Hill International Edn

ADDITIONAL REFERENCES

1. Physics – Classical & Modern Gettys, Keller, Skove McGraw–Hill International Edn
2. University Physics Young, Sears & Zemansky Narosa Publishing
3. Sound Khanna & Bedi
4. Heat & Thermodynamics Brijlal & Subramaniam Ratan Prakashan Mandir
   Heat & Thermodynamics Zemansky

Objectives:-

The subject will develop basics of Principles of Navigation / Practical Navigation and Voyage Planning & Collision Prevention .

Contents of syllabus for USNSC 102

NAVIGATION

		Theory	Practical
UNIT I	**SEMESTER – I** a) The shape of the earth, Poles, Equator, Great circles, Small circles, Prarllels of latitude, Latitude, D'Lat, Meridian, Prime meridian, Longitude, D'long, Position by latitude & longitude. b) Measurement of distance: Nautical, Geographical and Statute mile. Knot. Effect of polar compression on nautical mile.	**10 Hours**	-
UNIT II	a) Compass Points: True and Magnetic north.Magnetic variation and changes in its annual value. Isogonals. Deviation of magnetic compass, compass error. Course & Bearing. Conversion of compass course to true course and vice versa. b) Departure. Relationship between Departure and D'long. Parallel sailing.	**22 Hours**	
UNIT III	a) Rhumb Line: Mean latitude. Plane sailing. Relationship between departure, d'lat, course & distance. Middle Latitude. b) Principles of Mercator projection: Mercator chart, Natural Scale, Meridional parts; DMP. Latitude and longitude scales and conversion of one to the other;	**5 Hours**	
	PRACTICAL NAVIGATION 1. Practical problems on prarllel sailing using formulae. 2. Practicals problems on plane sailing using formulae. 3. Practicals problems on Mercator sailing using formulae. 4. The Use of Traverse Tables to obtain the position of the ship at any time, given compass course, variation, deviation, and the run recorded by the log or estimated speed or engine speed allowing for the effects of wind and current, if any. Day's work. 5. To find initial course, final course and distance between two positions on the earth's surface by Great Circle Sailing. 6. To calculate the position of the vertex and intermediate points on the Great Circle track.		**12 Hours**

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 70 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India.

Reference Books:-

BOOKS RECOMMENDED FOR REFERENCE:-

1. Practical Navigation — Capt. H. Subramaniam
2. Principles of Navigation — Capt. P.M. Sarma
3. Principles of Navigation — Capt. T.K Joseph and Capt. S.S.S. Rewari
4. Admiralty Manual of Navigation Vol. I & II HMSO
5. Navigation — A. Frost
6. Nicholl's Concise Guide Volumes I & II — Brown Son & Ferguson Ltd.

VOYAGE PLANNING & COLLISION PREVENTION

		Theory	Practical
UNIT I	**SEMESTER – I** 1. The nautical chart. Natural Scale, types of projections, Title of Chart, Number of Chart, Date of Publication. Deciphering the symbols and abbreviations used on a nautical chart. Units of Soundings used. How to read latitude and longitude. The use of parallel rulers to lay down or read courses and bearings. The compass Rose. The distance scale. Use of dividers to measure distances. Reason for using the nearest latitude scale for measuring distance. **COLLISION PREVENTION** 1. International Regulations for preventing collisions at sea. Application. Exceptions for local rules or harbours etc. Exception for special class of ships. Responsibility for the consequence of neglect of rules. Definitions of term 'Vessel'. 'Power driven vessel', 'sailing vessel', 'fishing vessel', 'seaplanes', 'Underway', 'restricted visibility'. Steering and sailing rules:	**Hours**	
UNIT II	1. Correction from Notices to Mariners. To find the date the chart was last brought up to date. Small and large Corrections. Degree of reliability of information shown on the chart. **COLLISION PREVENTION** Conduct of vessel in any condition of visibility, Maintenance of proper looks out. Maintenance of safe speed. Factors to be considered for determining safe speed. Determination of risk of collision with another vessel. use of radar in determining risk of collision. Use of visual bearings. Types of actions to be taken to avoid collision or close quarter situation	**08 hours**	**04 Hours**
UNIT	1. Types of chart – Ocean charts, coastal charts, harbour plans, Decca charts, Consol charts, Loran charts, Routing charts. The use of the Admiralty Catalogue to identify the charts required for voyage. **COLLISION PREVENTION** 2. Conduct of vessels in narrow channels and when approaching blind bends. Conduct of vessel in traffic separation schemes of International Maritime Organisation. **PRACTICALS** 1. a) To find compass error by transit bearings b) To find the position of a point on the chart by its latitude and longitude 2. a) To find the position of a point on the chart by its bearing and distance from a navigational marks b) To plot ship's position given the compass bearings of two or more shore objects. The 'Cocked hat' and the reasons for its formation 3. a) To plot ship's position given the rising or dipping bearing of a light. Caution during abnormal refraction	**10 Hours**	**04 Hours** **12 HOURS**

	b) To plot ship's position using three shore objects by horizontal sextant angles (given Horizontal sextant angle less than 90, equal to 90, or greater than 90). c) To plot ship's position, given vertical sextant angles and bearing of a light house.		

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 70 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

BOOKS RECOMMENDED FOR REFERENCE:-

1. Chartwork	Capt. S.S. Chaudhari
2. Chartwork for Mariners	Capt. Puri, S.K.
3. Voyage Planning & Chartwork	Capt. M.V.Naik & Capt. Varty
4. Nicholls Concise Guide Volume I	Brown Son & Ferguson
5. Marine Chartwork	Moore, D.A.
6. Rules for the Prevention of Collision at Sea	Bhandarkar Publications
7. Rule of the Road Manual	Capt. Puri, S.K
8. International Lights shapes and Sound Signals	Moore D.A.

Objective:-

This subject exposes the students to Ship Operation Technology Paper- I , Cargo Work & Communication
& Naval Architecture

Contents of syllabus for USNSC103

SHIP OPERATION TECHNOLOGY PAPER- I

		Theory	Practical
UNIT I	**SEMESTER – I** 1. GENERAL Names of various parts of ship. Names and timings of watches. Types of Names of various parts of ship. Names and timings of watches. Types of merchant navy vessels. Sea terms. Look-out. Compass points. Safety wearing apparel – Safety goggles, helmet, safety shoes. Removing rust by chipping hammers. Preparing a surface for painting. Paint brushes. Painting defects and their prevention. Cleaning of wooden decks. Cleaning and polishing of brass and copper.	**12 Hours**	-
UNIT II	1. LIFE SAVING APPLIANCES Classification of ships for Life Saving Appliances. LSA requirements for cargo ships. Life Boat: - Description of Lifeboat. Construction and parts of lifeboat. Buoyancy tanks. means of propulsion. Different classes of lifeboats used. Motor lifeboats, totally enclosed lifeboats, partially enclosed life boats. Determining the carrying capacity of a lifeboat. Equipment, ration and distress signals. types of boat davits and their method of operation.	**13 Hours**	
UNIT III	Liferaft: - inflatable and rigid. Construction and parts of life raft. Life raft equipment, ration and distress signals. repairing leaks and punctures. Getting into a liferaft. Inflatable chute. Life Buoy: - Description of a lifebuoy. Correct procedure for use of a lifebuoy. Life jacket: - description of a life jacket. Buoyant material used. The correct method of putting on a life jacket and jumping into water. Line throwing appliances: - description and use of line throwing appliance. Safety, care and maintenance of life saving appliances	**12 Hours**	
	PRACTICALS 1. To make and understand the use of various bends and hitches. mousing hooks and shackles. Breaking flags. To apply ropes and chain stoppers. To make various types of whippings. To perform various splices on natural and synthetic fibre rope.		**12 Hours**

	To perform various splices on wire ropes. Worming, parcelling and serving of hawsers. Throwing a heaving line. 2. Heaving the lead and calling out soundings. Slinging a stage. Precautions when using stages. Oiling wire ropes in situ by use of Bosun's chair. Safety precautions. Canvass sewing. Changing the canvass covering of a lifebuoy. Seizing: flat, round, racking. Parbuckling. Helm orders. steering practice. Changing boat falls. Streaming and hauling in a patent log. 3. Operating windlass and winches. Changing over from main steering to emergency steering system. Taking soundings of tanks and bilges. Measuring ullages. Taking freeboard and winches. Removing rust by chipping hammers. preparing a surface for painting. brush painting, spray painting. Cleaning of wooden decks – deck washing compounds		

There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 60 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

1. Life Boat and Life Raft — Capt. Puri S.K
2. Survival at sea — Wright C.H
3. Theory and Practice of seamanship — Danton G.
4. Seamanship Notes — Kemp & Young
5. Nicholls Seamanship — Brown Son & Ferguson Ltd
6. Life Saving Appliances Rules — Govt. of India
7. Fire Fighting Appliances Rules — Govt. of India

CARGO WORK & COMMUNICATION

		Theory	Practical
UNIT I	**SEMESTER – I** **CARGO GEAR** 1. **Blocks:** Parts of a block, different types of block, non-toppling and snatch blocks. External building. Internal binding. Strapped. Markings on a block. Size of a block and sheave, size of rope to be used in a block. Relationship between diameter of sheave and diameter of rope. **Tackles:** Names of parts of a tackle, using a tackle to advantages or disadvantage. Mechanical advantage, velocity ratio or 'power gained', efficiency of a tackle; relationship between pull on the hauling part and load. Types of tackles/purchases used on ships. **Shackles:** Various types. Markings on shackles. **MARINE COMMUNICATION** 1. Meaning of bunting, halyard, at the dip, close up, half mast, hoist, fly, tackline.	**12 Hours**	-
UNIT II	1. **Cargo hooks:** Various types. Markings on cargo hooks. **Ropes:** Care of ropes and wires used for cargo gear. **Derrick rigs:** The union purchase. Setting up of a union purchase. Importance of preventer guys. Maximum load to be used for angle between runners. Swinging derrick with powered guys. Putting winches in double gear. The Yo-Yo gear. Working of ships cranes. Hoisting, lowering and securing a derrick. **MARINE COMMUNICATION** Courtesy flag, ship's numbers, jack flag, quarantine flag, pilot flag, blue peter.	**12 Hours**	
UNIT III	1. **Stresses:** Calculating the stresses in various parts of a derrick rig. Calculating the tension on ropes and wires of a purchase and finding the correct size to be used. **MARINE COMMUNICATION** Location on a ship of jack staff. Ensign staff, Gaff, Triatic stay, foremast yardarm, main mast head.	**13 Hours**	
	PRACTICALS 1. To send and receive signals visually by Morse code 2. Recognition of national flags of all countries, Recognition of house flags and funnels of Indian Shipping Companies **3.** Recognition of flags denoting numbers and flags used as substitutes		**12 Hours**

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 60 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

1. Theory and Practice of seamanship — Danton G.
2. Seamanship Notes — Kemp & Young
3. Nicholls Seamanship — Brown Son & Ferguson Ltd
4. Cargo work — Kemp & Young
5. Seamanship Primer — Capt. J.M.N. Dinger
6. Cargo work — Capt. Errol Fernandes
7. International Code of Signals — HMSO
8. Stowage of Cargo — Capt. O.O. Thomas

NAVAL ARCHITECTURE

		Theory	Practical
UNIT I	**SEMESTER – I** INTRODUCTION: Development of ocean-going Merchant Ships. Modern merchant ships. TYPES OF SHIPS: types of ships based on nature of cargo. Passenger Liners, Ferries. Specialized carriers for General Cargo, Bulk, Oil (Crude Oil and Products) OBO's, Container, RO-Ro, Lash, LPG, LNG, Cattle, Cars, etc. Special features of above types of ships. DEFINITIONS & MEANINGS: LOA, LBP, EB, MB, Depth, Draft, Freeboard, Camber, Sheer, Rake, Rise of floor, Tumble Home, etc. GENERAL LAYOUT OF SHIPS: - General Cargo Ship, Bulk Carrier, Oil Tanker and Container Ship. Simple sketches of the same.	**17 hours**	**-**
UNIT II	PRINCIPAL PARTS OF A SHIP: Bow, Stern, Shell plating, Double Bottom Tanks, Cargo Holds, Tween Deck, Deep Tanks, Fore-peak and After Peak store rooms and tanks, Plates Keels and Duct Keels. Forecastle deck, Quarter Deck, Main/Weather decks, Hatch covers, Cargo Gear, anchoring and mooring equipments, etc. MACHINERY SPACES: Engine Room: Engine Casing, subdivisions of Engine Room. Steering Dear, Pump rooms, Mast houses, Workshops, etc. SUPERSTRUCTURE: Wheel House, accommodation spaces, cabins, galley, pantry, dining saloons, recreation rooms, various stores and lockers, cold storage spaces, etc.	**17 hours**	**-**
UNIT III	**SHIP STABILITY :** Laws of floating. Buoyancy, Reserve buoyancy, Displacement, Deadweight. Change of draft due to change of density. TPC. FWA. DWA. The centre of gravity of a ship and factors affecting the same. The centre of buoyancy and factors affecting the same. Calculations involving KG and KB of a ship. The meaning of the terms Block co-efficient, Water-plane coefficient, Mid-ship Coefficient, Prismatic Coefficient and relationship between them.	**16 hours**	**-**

***There will be continuous assessment of skills being acquired through class work, periodic assignments / project works / tests/ orals etc.**

NOTE : A candidate has to secure minimum percentage /grade : 60 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

1. Ship Construction notes — Kemp & Young
2. Ship Construction for Engineers — Reid
3. Ship construction — Pursey
4. Ship Stability I & II — Capt. Subramaniam H.
5. Problems on M. V. Hindship — Capt. Joseph & Capt. Rewari

Objective:-

This subject exposes the students to Environment Science – I, Marine Engineering & Control System- I

Contents of syllabus for USNSC
104 Environmental Science – I

		Theory	Practical
UNIT I	**SEMESTER – I** **PHYSICAL METEOROLOGY** **1. CHARACTERISTICS OF THE EARTH'S ATMOSPHERE**: Composition hydrostatic equation, equation of state for dry air and moist air. Density variation. Vertical layers of the atmosphere, Ozone depletion, air pollution. 2. ENERGY BUDGET: Radiation laws: Emission, Reflection, absorption and scattering. Solar and terrestrial radiation, Greenhouse effect and global warming, Heat exchange processes. Radiation budget of the earth/atmospheric system. Environmental lapse rate and inversion. Diurnal, seasonal and geographical variation of temperature.	**12 Hours**	-
UNIT I I	1. WATER VAPOUR IN THE ATMOSPHERE: Changes of state, specific, absolute and relative humility, dew points temperature, humidity mixing ratio. Unsaturated and saturated states, super-cooling, frost point. Diurnal and seasonal variation of water vapour. 2. ADIABATIC PROCESSES: Dry and saturated adiabatic lapse rates, Potential temperature. The tephigram and its uses. Stability analysis. 3. CONDENSATION AND PRECIPITATION PHENOMENA: Condensation and freezing nuclei, condensation forms: Dew, frost, mist, fog, haze and clouds. Visibility. Development and classification of clouds. 4. PRECIPITATION: Processes, forms and types. Principles and methods of surface meteorological observations.	**12 Hours**	-
UNIT I I I	**OCEANOGRAPHY** 1. PHYSICAL PROPERTIES OF SEA WATER: Temperature, Salinity, density and pressure – their relationship and measurement. Optical properties, sound and light in the sea, colour of the sea water. Salinity and density distribution in surface layers of the ocean. Controlling processes. The energy budget, heat balance of the oceans and spatial variation of temperature and evaporation. 2. OCEANIC CIRCULATION SYSTEM: Causes and the spatial distribution of surface circulation. Seasonal changes. Sub-surface circulation formation, source region and movement of water masses. 3. **OCEANIC WAVES AND TIDES**: Types of waves, wave energy, behaviour of waves in deep and shallow waters. Tide-producing forces. Types of tides. Tide prediction and analysis, tidal streams, co-tidal charts. Storm surges and tsunamis.	**14 Hours**	
	PRACTICALS 1. METEOROLOGY: The principles, construction and uses of various meteorological instruments, maximum and minimum thermometers, psychrometer/hygrometer, anemometer, wind vane. Barometers (aneroid and mercury) and barograph. 2. OCEANOGRAPHY: Use of main instruments and observational methods in the sea environment: Sensors for temperature, salinity, depth, velocity etc.	-	**12 Hours**

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 50 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

METEOROLOGY		
Marine Meteorology	Capt. H. Subramaniam	Vijaya Publications
Atmosphere, Weather	Barry R. G. & Chorley R. J.	Metheun – London
Introduction to Theoretical Meteorology1	Hess	
Meteorology for Mariners	HMSO, London	HMSO
Marine Observer's	HMSO, London	Newyork / London
Handbook Elementary Meteorology	HMSO, London	HMSO
An Introduction to Meteorology	James, R. Holton	Academic Press
Introduction to Meteorology	Petterson B.	

MARINE ENGINEERING & CONTROL SYSTEM- I

		Theory	Practical
UNIT I	**SEMESTER - I** 1. Strength of materials – Elasticity, Hook's Law – Stress and Strain Tensile, Compressive and Shear forces. Failure of materials under tension, compression, shear and fatigue. Examples related to Marine Engineering. 2. Cantilever and simply supported Beams, Shear force and Bending Moments, calculation of stresses and B.M. Diagrams for above and other systems of the ship. Mechanical properties of common engineering materials – hardness, ductility, malleability, melting point etc.	**12 Hours**	-
UNIT II	SECTION –B 1. Fluid Mechanics – Flow of liquids and gases, Laminar and Turbulent flow, Resistance to flow. Viscosity – definition and meaning. Bernoulli's Theory – Simple treatment Loss of energy of fluid due to bends, friction, valves etc. Simple hydraulic equipments. Thermodynamics – Properties of steam; Boiling point and effect of pressure on it; Saturated, dry and superheated steam; Dryness fraction. Meaning of Sensible Heat and Latent Heat.	**13 Hours**	
UNIT III	Electrostatics, Electro-magnetism and Electricity. Electric current, Voltage, EMF, Ohm's Law, Direct Current (DC) and Alternating Current (AC). Simple electrical circuits, Kirschoff's laws, simple calculations, Wheatstone bridge	**12 Hours**	
	PRACTICALS Brief description of drawing papers, pencils, Instruments and their use. Types of lines and dimensioning. Loci of points, orthographic projection of points, Straight lines, Planes, Solid. Isometric Projection. Concept of Form and shape, Plan, Elevation and End views of objects.		**12 Hours**

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 50 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

1. Basic Marine Engineering J.K. Dhar
2. Engineering Drawing Bhat
3. Engineering knowledge for Deck Officers Reed
4. General Engineering knowledge Vol. 8 Reed
5. Mechanical Engineering Science Hannah & Hiller

Marine Auxiliary Machinery Souchette & Smith

B.Sc. in Nautical Science

Theory/Practical : 16 Weeks (15 weeks for lectures/practical & one week for semester end examination)

Semester –II

Semester-I								
B.Sc In Nautical Science								
Theory / Practical :								
Course Code	**Title Of The Course**	**Per Week**		**Per Semester**		**Credits**		**Total**
		L	**P**	**L**	**P**	**L**	**P**	
USNSC101	English & Communication Skills	3	1	45	15	4	2	6
	Applied Mathematics-I	6		90				
	Nautical Physics & Electronics-I	4	2	60	30			
USNSC102	Navigation -I	3	1	45	15	3	2	5
	Voyage Planning & Collision Prevention - I	2	2	30	30			
USNSC103	Ship Operation Technology-I	3	1	45	15	3	2	5
	Cargo Work & Marine Communication	3	1	45	15			
	Naval Architecture-I	3		45				
USNSC104	Environmental Science-I	3	1	45	15	2	2	4
	Marine Engineering & Control Systems-I	3	1	45	15			
		33	10	495	150	12	8	20

Semester –II

Theory / Practical :								
Course Code	Title Of The Course	Per Week		Per Semester		Credits		Total
		L	P	L	P	L	P	
USNSC201	English & Communication Skills	3	1	45	15	3	2	5
	Applied Mathematics-II	6		90				
	Nautical Physics & Electronics - II	4	2	60	30			
USNSC202	Navigation -I	3	1	45	15	3	3	6
	Voyage Planning & Collision Prevention - I	2	2	30	30			
	Marine Engineering & Control Systems - I	3	1	45	15			
USNSC203	Ship Operation Technology-I	3	1	45	15	3	2	5
	Cargo Work & Marine Communication	3	1	45	15			
	Naval Architecture-I	3		45				
USNSC204	Environmental Studies	3	1	45	5	2	2	4
		33	10	495	140	11	9	20

ENGLISH & COMMUNICATION SKILLS /PHYSICS /MATHS

Contact Hours 195

Name of the Programme	**Duration**	**Semester**	**Course/ Course Code**
B.Sc in Nautical Science	Six Semesters	II	English / Physics/Maths [USNSC 201]
Course Code	Title	Credits	
USNSC 201	English/Physics/Maths	4+2	

For Course per week 1 lecture/period is 60 minutes duration				**For subject** per week 1 lecture/period is 60 minutes duration			
	Theory	Practical	Tutorial	English	Maths	physics	
Actual contacts	13	3	--	3	6	4	
Credits	4	2	--	1		2	

NAVIGATION –I / MARINE ENGINEERING & CONTROL SYSTEM

VOYAGE PLANNING & COLLISION PREVENTION - I Contact Hours 120

Name of the Programme	**Duration**	**Semester**	**Course/ Course Code**
B.Sc in Nautical Science	Six Semesters	II	Navigation-1 Voyage Planning & Collision Prevention [USNSC 202]
Course Code	Title	Credits	
USNSC 202	Navigation-1 Voyage Planning & Collision Prevention	3+2	

For Course per week 1 lecture/period is 60 minutes duration				**For subject** per week 1 lecture/period is 60 minutes duration	
	Theory	Practical	Tutorial	Navigation-I	Voyage Planning & Collision Prevention
Actual contacts	5	3	--	3	2
Credits	3	2	--	1	2

SHIP OPERATION TECHNOLOGY PAPER- I
CARGO WORK & MARINE COMMUNUCATION
NAVAL ARCHITECTURE-I **Contact Hours 135**

Name ofthe Programme	**Duration**	**Semester**	**Course/ Course Code**
B.Sc in Nautical Science	Six Semesters	II	Ship Operation Technology Paper- I Cargo Work & Communication Naval Archietecture [USNSC 203]
Course Code	Title	Credits	
USNSC 203	Ship Operation Technology Paper- I Cargo Work & Communication Naval Archietecture	3+2	

For Course per week 1 lecture/period is 60 minutes duration				**For subject** per week 1 lecture/period is 60 minutes duration			
	Theory	Practical	Tutorial	SOT Paper- I	Cargo Work & Comm.	Naval Architecture Paper- I	
Actual contacts	9	2	--	3	3	3	
Credits	3	2	--	1	1	-	

ENVIRONMENTAL SCIENCE-I

Contact Hours 45

Name of the Programme	**Duration**	**Semester**	**Course/ Course Code**
B.Sc in Nautical Science	Six Semesters	II	Environment Studies – I [USNSC 204]
Course Code	Title	Credits	
USNSC 204	Environment Studies – I	2+2	

For Course per week 1 lecture/period is 60 minutes duration				**For subject** per week 1 lecture/period is 60 minutes duration		
	Theory	Practical	Tutorial	Environment Science – I	Marine Engineering & Control System- I	
Actual contacts	06	02	--	3	3	
Credits	02	02	--	1	1	

Objective:-

This subject exposes the students to English & Communication skills , Applied Mathematics & Nautical Physics

Contents of syllabus for USNSc 201

ENGLISH

		Theory	Practical
UNIT I	**SEMESTER – II** Comprehension (15) (20 Marks) a) Seen and unseen comprehension. b) Technical writing definition and characteristics	**11 Hours**	-
UNIT II	Writing Skills. a) Maritime correspondence. b) Report writing c) Welcome address d) Vote of thanks e) Essay writing	**22 Hours**	
UNIT III	a)Importance of SMCP and English language among multilingual crew. b) Inquiry on completion of routine operations. c) Sea speak – Internal and external communication on board. d) Facing an interview e) Presentation skills - individual activities	**5 Hours**	
	PRACTICAL All topics covered in unit III		**13 Hours**

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 40 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

Communication skills (Book 1)	S.R. Inthira & V. Saraswati
Communication skills workbook	S.R. Inthira & V. Saraswati
Spoken English for India	R.K. Bansal & B. Harrison

BOOKS RECOMMENDED FOR REFERENCE

English language Books 1 and 2 L.A. Hill, C.J. Daswani & C.T. Daswani (Oxford University Press 1975)

Written communication	Freeman and Sarah
Note marking and composition exercises 1979	ELT Cell, Bombay University
Business correspondence and report writing	R.C. Sharma and Krishnamohan
Academic skills Academic	CIEFL, Hyderabad
skills workbook	CIEFL, Hyderabad
Supplementary Reader Sea	CIEFL, Hyderabad
Speak manual	International Maritime Organisation.

APPLIED MATHS

		Theory	Practical
UNIT I	**SEMESTER - II** 1. **Integral Calculus & Beta & Gama Functions** Rectification of plane curves. Double & Triple integrals, their geometrical interpretation and evaluation. Evaluation of double integrals by change of order and change to polar form. Applications of double & triple integrals to areas and volumes, Centre of Mass, Moment of Inertia, Applications of integration to the evaluation of first and second moments of areas and volumes. a) Beta & Gama functions & their properties, relations between Beta & Gama functions. b) Error functions c) Differentiation under integral sign.	**35 Hours**	-
UNIT II	2. **Infinite Series and Fourier Series** Convergence of infinite series, uniform convergence, properties of uniformly convergent series, power series and their properties, expansion of a function as power series, Exponential and logarithmic series, definition of Trigonometric and Fourier series, Fourier coefficients, Dirichlet's conditions, statement of Dirichlet's theorem, expansion of functions in Fourier series, Even and Odd functions, half range Four series, Complex form of Fourier series, Differentiation and Integration of Fourier Series, Fourier series with respect to a set of orthogonal functions over (a,b). [Fourier series over $(-\pi, \pi)$,$(0,2\pi)$ and for arbitrary range (a, a+2L) must be treated].	**30 Hours**	
UNIT III	3. **Spherical trigonometry & Simpson's Rules** Properties of a spherical triangle and oblique spherical triangle. Cosine formula, Haversine formula, Sine formula and four part formula and their application to Navigations problems. Polar triangle and application of their properties. Right angle and quadrantal triangle. Napier's Rules and their application to Navigational problems. Area of spherical triangles. Inequalities, Derivation of formula by supplemental theorem, 'Half angle' formula, 'Half side' formula, Identities. Delambre's Analogies Napier's Analogies, Legendre's theorem. Derivation of Simpson's first, second and five-eight rules and their use in the computation of areas volumes and centroids.	**35 Hours**	

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NOTE : A candidate has to secure minimum percentage /grade : 40 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

BOOKS RECOMMENDED FOR REFERENCE:

1. Higher Mathematics for Engineers and Physicists	Sokolnikoff. I.S & Sokolnikoff. E.S.
2. Advanced Calculus	Wilfred Kaplan
3. Spherical Trigonometry	Capt. H. Subramanian
4. An introduction to spherical Trigonometry	Clough – Smith. J.H.
5. Ship Stability for Master and Mates	Derret. D.R.
6. Higher Engineering Mathematics	Grewal. B.S
7. integral Calculus	Shanti Narayan
8. Text Book of Applied Mathematics	Wartikar. P.N. & Wartikar. J.N.

NAUTICAL PHYSICS

		Theory	Practical
UNIT I	**SEMESTER – II** ELECTRICITY AC and DC voltages, dangerous levels, precautions. Static electricity and its hazards. Work, energy, power in a circuit. Magnetic Effect: Magnetic field due to a stationary coil, Electromagnet, Circular lifting magnet. Review of electro – magnetic induction. Faraday – Lenz's Law, transformer. The AC generator,	**20 Hours**	**-**
UNIT II	ELECTRONICS Semiconductors of p and n type, p-n junction diodes-their characteristics, half-wave, full wave & bridge rectifiers, voltage regulation. Ripple, Capacitor filter, Zener Diode, its uses as a voltage regulator. Thermistors: - Use in temperature control. Transistors: - pnp, npn, 3 modes of operation, current gains α and β. Photoelectric effect, opto-electronic devises – LDR, LED. 7 – Segment displays, photo diode, photo transistor.	**20 Hours**	
UNIT III	MAGNETISM & MODERN PHYSICS Earth as a magnet, magnetic elements and their variation. Magnetism of the ship and its components. Effect of motion of the ship and latitude on the compass. Radioactivity, emissions from natural radioactive nuclei, radioactive series. Detection of radiation, GM counter, radiation units. Radiation damage, Nuclear fission and fusion, Nuclear Reactors. **EXPERIMENTS** Series L-R and C-R AC circuits, Determination of impedance, L & C. Magnetic elements of the earth, use of a Dip circle. Use of multimeter (analog and digital) to determine resistance. Comparison with color code value. Use of multimeter (analog and digital) for testing of diodes and transistors.	**35 Hours**	
	Forward and Reverse characteristics of Rectifier Diode and a Zener Diode. CE characteristics of an npn transistor, Determination of α and β. Half wave Rectifier – Voltage regulation and ripple. Effect of a capacitor filter. Bridge rectifier – Voltage regulation and ripple. Effect of a capacitor filter. Study of an IC voltage Regulation, Voltage regulation and		**25 Hours**

	ripple. LED and LDR characteristics. Use of Digital multimeter and DPMs is preferred for measurement of voltage and current. Ripple to be obtained on CRO. **NOTE:** A minimum of 8 experiments are expected to be performed		

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***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 40 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

Electronic Principles	Malvino	Tata McGraw Hill.
Electronic Devices and Circuits	Boylestead & Nashelsky	Prentice Hall India.

ADDITIONAL REFERENCES

Physics-Classical & Modern Edn	Gettys, Keller, Skove	McGraw–Hill International
University Physics	Young, Sears & Zemansky	Narosa Publishing
Electricity & Magnetism	Brijlal & Subramaniam	Ratan Prakashan Mandir
Physics Part II	Halliday & Resnick	
Modern Physics	B.L. Thareja	
Basic Electronics	B.L. Thareja	

BOOKS FOR PRACTICALS FOR PAPER I & II

Advanced level Practical Physics	M. Nelkon & J.M. Ogborn	ELBS
Electronics – A Test Lab Manual	Zabar	Tata McGraw Hill

Objectives:-

The subject will develop basics of Principles of Navigation / Practical Navigation and Voyage Planning & Collision Prevention .

Contents of syllabus for USNSC
202 NAVIGATION I

		Theory	Practical
UNIT I	**SEMESTER - II** 1. a) Mercator sailing. Relationship between Course, D'long and DMP. b) Principle of Gnomonic projection. Gnomonic chart.	**06 Hours**	-
UNIT II	2. a) Dead Reckoning position (DR), Estimated position (EP) & Observed position (Fix). Set and drift of current. Leeway. b) Spherical triangle. Great circle sailing: initial course, final course, distance and vertex.	**22 Hours**	
UNIT III	3. a) Solar System: Rotation and Revolution. Equinoxes and solstices. Cause of seasons and unequal length of day and night. b) The principle of the Sextant and the Azimuth Mirror. **PRACTICAL NAVIGATION** The chronometer. Checking chronometer error by radio signals. Finding U.T and correct date. The micrometer Sextant. Arc of excess. Error of perpendicularity. Side error. Index error on the arc and off the arc. Collimation error. Taking vertical and horizontal angles. Position fixing by bearing and vertical sextant angle of a lighthouse. Position fixing by horizontal angles between three or more points. Recognition of important stars with reference to stellar constellations. The use of Azimuth mirror and Pelorus. Procedure for checking accuracy of azimuth mirrors. The use and care of magnetic compasses. Precautions to be observed while taking compass bearings. Practical limitations of the magnetic compasses	**10 Hours**	**13 Hours**

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***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 70 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

1. Practical Navigation — Capt. H. Subramaniam
2. Principles of Navigation — Capt. P.M. Sarma
3. Principles of Navigation — Capt. T.K Joseph and Capt. S.S.S. Rewari
4. Admiralty Manual of Navigation Vol. I & II — HMSO
5. Navigation — A. Frost
6. Nicholl's Concise Guide Volumes I & II — Brown Son & Ferguson Ltd.

VOYAGE PLANNING & COLLISION PREVENTION I

		Theory	Practical
UNIT I	**SEMESTER – II** **VOYAGE PLANNING** Meaning of Chart Datum. Reference point used for heights. Nature of bottom. Depth Contours. Information regarding lights. Height, colour and characteristics of lights. Use of leading lights for safe navigation in harbour. Horizontal sectors of lights and their use by navigators in keeping clear of submerged dangers to navigation. Use of sectors in laying courses. Use of clearing marks and horizontal and vertical danger angles. Sailing round an arc. **COLLISION PREVENTION** Conduct of vessel in sight of one another, Responsibilities to keep out of way when two sailing vessels are on collision course. Responsibility to keep out of way when one vessel is overtaking another vessel of any type. Action to be taken by a vessel when meeting another vessel head on. Responsibility to keep out of way when two vessels are crossing each other.	**08 Hours**	**04 Hours**
UNIT II	**VOYAGE PLANNING** True, Magnetic and Compass North. Variation. Annual rate of change of variation. How to obtain variation from date given on the compass Rose. Derivation of the compass. The Deviation Card. True, magnetic and Compass course. Conversion of one to another. the compass error for the ship's head. True, magnetic and Compass bearings. Conversion of one to another. Gyro Error, High and Low, Conversion of Gyro courses to True course and vice versa. **COLLISION PREVENTION** Action to avoid collision. Duty of the vessel which has the right of way. Action to be taken by such vessel required to keep out of way is not taking avoiding action. Right of way between a normal power driven vessel, a vessel not under command, a vessel restricted in her ability to manoeuvre, a vessel engaged in fishing, a sailing vessel and a vessel constrained by her draft.	**08 Hours**	**04 Hours**
UNIT III	**VOYAGE PLANNING** The effect of current on course made good. Set and drift. The effect of wind on course made good. Leeway. The dead Reckoning Position, Estimated Position and Observed Position. **COLLISION PREVENTION** Conduct of vessel in restricted visibility , Applicability. Determination of risk of collision when another vessel is detected by radar alone. Actions to be taken / avoided to prevent close quarter situation with a vessel detected on radar alone. Action to be taken when fog signal of another vessel is heard but vessel is not seen though it may have been detected by radar	**08 Hours**	**04 Hours**

	PRACTICALS 1. a) To plot position lines obtained by Radio Aids to navigation. b) To plot a position line obtained by an astronomical observation c) To find compass course between two positions on the chart 2. a) To find compass course to seer between two positions on the chart so as to counteract the given set and drift of current and given leeway b) To find the course and distance made good, given course steered, set and drift of current and leeway. 3. a) To find the course and speed made good and the set and drift, given the course steered, speed, duration and the initial and final observed positions. b) To find the course from a given position so as to pass a lighthouse at a given position so as to pass a lighthouse at a given distance when abeam		**14 Hours**

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 70 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

BOOKS RECOMMENDED FOR REFERENCE:-

1. Chartwork — Capt. S.S. Chaudhari
2. Chartwork for Mariners — Capt. Puri, S.K.
3. Voyage Planning & Chartwork — Capt. M.V.Naik & Capt. Varty
4. Nicholls Concise Guide Volume I — Brown Son & Ferguson
5. Marine Chartwork — Moore, D.A.
6. Rules for the Prevention of Collision at Sea — Bhandarkar Publications
7. Rule of the Road Manual — Capt. Puri, S.K
8. International Lights shapes and Sound Signals — Moore D.A.

Objective:-

This subject exposes the students to Ship Operation Technology Paper- I , Cargo Work & Communication & Naval Architecture

Contents of syllabus for USNSC 203
Ship Operation Technology Paper- I

		Theory	Practical
UNIT I	**SEMESTER – II** . Fire fighting appliances:- Fire hydrants and hoses. types of connections. International shore connection. Types of nozzles. Description of portable fire extinguisher, various types and their suitability for different types of fires. Operation and refilling of the extinguishers. principle of fire extinguishing used in each type. Safety devices: fireman's outfit, Smoke helmet and self-contained breathing Apparatus (SCBA). Safety lamps and their arrangement for prevention of sparks. Fire axe. Asbestos suit. Fixed smothering system: brief description of steam smothering system, carbon dioxide smothering system, inert gas system, Flue gas system, Halon system, Foam smothering system for liquid fires, High expansion foam system. Safety, care and maintenance of all fire fighting appliances.	**12 Hours**	-
UNIT II	. ROPES AND WIRES:- Types of material used, natural fibres, synthetic fires. Types of lay of ropes and their advantages. Plaited ropes. Characteristics of different types of fibre ropes. Comparison of strength and elasticity of different ropes. care and maintenance of fibre ropes. Damage caused by surging. Meaning of marline, spun yarn, oakum, tarred hemp, 3 ply and 5 ply twines, halliards, loglines, lead lines. Grades of steel used for making wire ropes. Construction of wire ropes. Advantage of a fibre heart. Factors determining flexibility. Meaning of 6/12, 6/24, 6/37, types of wire ropes. plaited wire rope. plastic covered wire rope. Non-rotating wire rope. Care and maintenance of wire ropes. Measuring sizes of ropes, wire and chains. Breaking strength and safe working load of ropes, wires and chains. To calculate the size of rope or wire required for lifting a weight with a tackle	**13 Hours**	
UNIT III	. DECK APPLIANCES Description of the head-lead line. procedure for taking a cast. Different types of logs. Patent log, impeller log, electromagnetic log, pilot log. principles of their operation. The electric telegraph, description and its operation. Windlass & cargo winches – description and their operation. Telemotor steering gear. The hydraulic transmitter, telemotor receiver, transmission of steering wheel signals to steering engine. Pressure equalising system. Fluid used. Cross head and floating link connection. Principle of 'Hunting Gear' Electric steering gear. The Wheatstone principle of transmission of steering wheel signals to steering engine. Inter-switching of follow-up and non follow-up steering systems.	**13 Hours**	

	PRACTICALS 1. Cleaning and polishing of brass and copper. Swinging out and lowering a lifeboat from luffing and gravity davits. Use of Tricing pendants. Handling of life boat under oars – coming alongside, getting away and picking up a man overboard. Handling of lifeboat under sail: types and parts of sails. Setting sail. Sailing a lifeboat. Handling of boats in rough weather: heaving to. use of sea anchor and steering oar. Rescuing a man overboard. Starting the engine of a motor lifeboat. man overboard drill. Turning short around, towing other crafts. 2. Hoisting a lifeboat on davits. Checking the working of cut-off switches. Launching of liferafts. Inflating liferafts. Method of righting a liferaft which has inflated upside down, boarding a liferaft jumping into the water. Getting away from ship. Artificial respiration. Use of lifeboat WT: installation of aerial. Tuning the transmitter. Transmitting automatic distress signal. Transmitting manually. Receiving. Listening times for distress calls. Donning a smoke helmet and self contained breathing apparatus. 3. Boat and fire drill. Sounding emergency signal. Action on hearing the emergency signal. Coiling ropes. Cutting wire ropes. Opening a new coil. Charging of various type of fire extinguishers. To make and understand the uses of the knots used on board ships for various purposes.		**15 Hours**

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**

***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 60 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

1. Life Boat and Life Raft — Capt. Puri S.K
2. Survival at sea — Wright C.H
3. Theory and Practice of seamanship — Danton G.
4. Seamanship Notes — Kemp & Young
5. Nicholls Seamanship — Brown Son & Ferguson Ltd
6. Life Saving Appliances Rules — Govt. of India
7. Fire Fighting Appliances Rules — Govt. of India

CARGO WORK & COMMUNICATION

		Thoery	Practical
UNIT I	**SEMESTER – II** **CARGO WORK** **Slings:** Types of slings used for lifting cargo of different types. Accident prevention when working cargo. **Overhauling blocks**: Care and maintenance. Reeving a three fold purchase. **Hatch-Covers:** Types of hatches. Opening and closing of Mcgregor and Hydraulic hatch covers. Closing arrangements. Battening down a hatch. **MARINE COMMUNICATION** What flags are hoisted from these parts of ship and when.	**12 Hours**	-
UNIT II	TRANSPORTATION OF GOODS BY SEA: - Categories of cargo, bulk solid, bulk liquid, chemical in bulk, gas, dangerous goods, general cargo. Methods of carrying cargoes, tanks, containers, holds, portable tanks aboard ship, ro-ro, refrigerated containers and holds. Loading/discharging/lashing of Heavy Lifts and deck cargoes. Stowage Plan Cargo hold preparation and inspection prior loading. **MARINE COMMUNICATION** Types of ensigns.	**13 Hours**	
UNIT III	CARGO CARE: - Importance of cargo care to economical operation of ship. Care of cargo on board ship. Securing cargo by using Bull-dog grips and bottle screws. Securing by chains and tensioners. Container lashing and securing. Fire prevention, interaction, temperature variations leading to sweat Damage (cargo sweat & ship sweat), sea water damage, ventilation to avoid hazardous gas accumulations, dunnage, separations, bulkheads, shifting boards. **MARINE COMMUNICATION** Penalty for not using or wrongly using an ensign.	**13 Hours**	
	PRACTICALS 1. How to bend on or unbend a flag from halyard. Breaking a flag at close up 2. Flag hoisting practice at colours and sunset 3. Morse signalling with Aldis lamp on mains and battery Morse signalling with Daylight signalling Apparatus		**13 Hours**

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***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 60 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

1. Theory and Practice of seamanship — Danton G.
2. Seamanship Notes — Kemp & Young
3. Nicholls Seamanship — Brown Son & Ferguson Ltd
4. Cargo work — Kemp & Young
5. Seamanship Primer — Capt. J.M.N. Dinger

6.	Cargo work	Capt. Errol Fernandes
7.	International Code of Signals	HMSO
8.	Stowage of Cargo	Capt. O.O. Thomas

Naval Architecture

		Theory	Practical
UNIT I	**SEMESTER – II** PRINCIPLES OF DESIGN: Common principles governing design and construction of various types of steel ships with respect to : Longitudinal, transverse and vertical strength. Continuity of strength Strength – under static and dynamic conditions. Stability Water – tightness. Conformity with statutory requirements.	**16**	**-**
UNIT II	STEEL FOR SHIP CONSTRUCTIONS: Types of steel used in ship construction. Steel plates and their treatment. Rolled sections – various shapes and standard sizes. Casting and forging and their us in construction. Testing of materials – various tests at production and building stages. RIVETING & WELDING: Riveting as a joining process. Welding – its predominant use in ship construction. Advantages of welding over riveting in ship construction. General ideas of Electric welding equipment, coated electrodes, methods used, etc. Gas welding, Gas cutting. Precautions while welding.	**16**	
UNIT III	**SHIP STABILITY :** Use of displacement and TPC curves and scales to determine weight of cargo or ballast from draughts or freeboards. Meta centric height, Righting lever, Righting Moment. Stable, Unstable and Neutral equilibrium. Free Surface Effect. Stiff and Tender ships. Difference between heel and list. Use of hydrostatic tables and curves as supplied to ships. Calculations based in the foregoing topics.	**18 Hours**	

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NOTE : A candidate has to secure minimum percentage /grade : 60 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

1. Ship Construction notes — Kemp & Young
2. Ship Construction for Engineers — Reid
3. Ship construction — Pursey
4. Ship Stability I & II — Capt. Subramaniam H.
5. Problems on M. V. Hindship — Capt. Joseph & Capt. Rewari

Objective:-

This subject exposes the students to Environment Studies – I

Contents of syllabus for USNSC 204

Environmental Studies – I

		Theory	Practical
UNIT I	**SEMESTER – I I** **1 (1). The Multidisciplinary Nature Of Environmental Studies:** Definition, Scope, Importance, Need for public awareness 2 (2). NATURAL RESOURCES: Renewable and non-renewable resources: a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Case studies. d) Food resources: World food problem, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. Case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. ● Role of an individual in conservation of natural resources. ● Equitable use of resources for sustainable lifestyles. 3 (3). ECOSYSTEMS: ● Equitable use of resources for sustainable lifestyles. ● Structure and function of an ecosystem. ● Producers, consumers and decomposers. ● Energy flow in the ecosystem. ● Ecological succession. ● Food chains, food web and ecological pyramids. ● Introduction, types, characteristic features, structure and function of the following ecosystems: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries)	16 Hours	-
UNIT I I	1 (4). **BIODIVERSITY AND ITS CONSERVATION:** ● Introduction – Definition: Genetic. Species and ecosystem diversity. ● Biogeographical classification of India. ● Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values. ● Biodiversity at global, national and local levels. ● India as a mega diversity nation. ● Hot-spots of biodiversity. ● Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife Conflicts. ● Endangered and endemic species of India.	16 Hours	-

	● Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. 2 (5). ENVIRONMENTAL POLLUTION: Definition ● Causes, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f . Thermal pollution g. Nuclear hazards ● Solid waste management: Causes, effects and control measures of urban and industrial waste. ● Role of an individual in prevention of pollution. ● Pollution case studies. ● Disaster management: Floods, earthquakes, cyclone and landslides.		
UNIT I I I	1 (6). SOCIAL ISSUES AND THE ENVIRONMENT: ● From Unsustainable to Sustainable development. ● Urban problems related to energy. ● Water conservation, rain water harvesting, watershed management. ● Resettlement and rehabilitation of people; its problems and concerns. Case studies. ● Environmental ethics: Issues and possible solutions. ● Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. ● Wasteland reclamation. ● Consumerism and waste products. ● Environment Protection Act. ● Air (Prevention and Control of Pollution) Act. ● Water (Prevention and Control of Pollution) Act. ● Wildlife Protection Act. ● Forest Conservation Act. ● Issues involved in enforcement of environmental legislation. ● Public Awareness. 2 (7). HUMAN POPULATION AND THE ENVIRONMENT: ● Population growth, variation among nations. ● Population explosion – Family Welfare Programme. ● Environment and human health. ● Human Rights. ● Value Education. ● HIV / AIDS. ● Women and Child Welfare. ● Role of Information Technology in Environment and Human health. ● Case Studies.	13 Hours	-
	PRACTICALS ● Visit to a local area to document environmental assets – River / Forest / Grassland / Hill / Mountain. ● Visit to local polluted site – Urban / Rural / Industrial / Agricultural. ● Study of common plants, insects, birds. ● Study of simple ecosystems – Pond / River / Hill slopes, etc.	-	5 Hours

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***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 50 % as per UGC guidelines.

Reference Books:-

METEOROLOGY

Marine Meteorology	Capt. H. Subramaniam	Vijaya Publications
Atmosphere, Weather	Barry R. G. & Chorley R. J.	Metheun – London
Introduction to Theoretical Meteorology1	Hess	
Environmental studies for undergraduate courses	Erach Bharucha	Mum University
Marine Observer's	HMSO, London	Newyork / London
Handbook Elementary Meteorology	HMSO, London	HMSO
An Introduction to Meteorology	James, R. Holton	Academic Press
Introduction to Meteorology	Petterson B.	

MARINE ENGINEERING & CONTROL SYSTEM- I

		Theory	Practical
UNIT I	**SEMESTER - II** SECTION - A 1. General introduction and scope. Classification of ships as per propulsion plants. general layout of ship's Engine Rooms and machinery.	**12 Hours**	-
UNIT II	SECTION-B Main Engine Plants and supporting systems. Introduction about ship's Auxiliary Systems. Electrical Power Generation Plants – Its supporting systems	**16 Hours**	
UNIT III	SECTION-C Bilge, ballast, fire, cargo & other pipelines of different type of ships.	**10 Hours**	
	PRACTICALS Contours, change of sections, hidden (Internal) construction, dotted lines, etc. discussion on ship's plans. Isometric views, cut/cross sections. Simple assembly drawings. Engineering drawing by free hand sketching. NOTE: Sufficient time should be allotted for drawing-practice.		**13 Hours**

***There will be continuous assessment of skills being acquired through class work, practical and periodic assignments / project works / tests/ orals etc.**
***Journal to be submitted at the end of each term for assessment**

NOTE : A candidate has to secure minimum percentage /grade : 50 % as per Training Circular No 4 of 2005 by DG Shipping , Govt Of India

Reference Books:-

1. Basic Marine Engineering — J.K. Dhar
2. Engineering Drawing — Bhat
3. Engineering knowledge for Deck Officers — Reed
4. General Engineering knowledge Vol. 8 — Reed
5. Mechanical Engineering Science — Hannah & Hiller
6. Marine Auxiliary Machinery — Souchette & Smith

Scheme of Examination:

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 25% marks in the first part & by conducting the Semester End Examinations with 75% marks in the second part.

The Course having Practical training will have Practical Examination for 50 marks at the end of Semester, out of which 30 marks for the Practical task assigned at the time of examination. The 20 marks are allotted as Internal Assessment.

The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

Internal Assessment : It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the Credit based system by way of participation of learners in various academic and correlated activities in the given semester of the progamme.

Semester End Assessment : It is defined as the assessment of the learners on the basis of Performance in the semester end Theory/ written/ Practical examination.

Modality of Assessment :

Internal Assessment - 25% **25 marks.**

a) Theory **25 marks**

Sr No	Evaluation type	Marks
1	One class Test (multiple choice questions objective)	20
2	Active participation in routine class instructional deliveries. Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05

B) External examination - 75 %

Semester End Theory Assessment - 75% **75 marks**

i. Duration - These examinations shall be of 2.5 hours duration.

ii. Theory question paper pattern :-

1. There shall be four questions.
2. On each unit there will be one question & fourth one will be based on entire syllabus.
3. Question number 1, 2 & 3 will be 20 marks(40 marks with internal option) each and question number 4 will be 15 marks (30 marks with internal option).
4. All questions shall be compulsory with internal choice within the questions.
5. Questions may be sub divided into sub questions a, b, c, d & e only & the allocation of marks depends on the weight age of the topic.

Practical External Assessment **50 marks**