Syllabus for Qualifying Examination for PhD Submission
(Marine Thermal Group)

Thermodynamcis

Thermodynamic systems, Micro & Macro systems, Concept of continuum- Pure substance- Thermodynamic equilibrium, State Property, Path, Process- Reversible and irreversible cycles- Energy as a property of the systems- Energy in state and transition, Work, Heat, Point function, Path function- Zeroth law of thermodynamics- Concept of equality of temperatures- Joule's experiments- First law of thermodynamics- Corollaries- First law applied to flow systems- Systems undergoing a cycle and change of state- First law applied to steady flow processes- Limitations of first law of thermodynamics. Perfect gas laws- Equation of state- Universal gas constant, various non-flow processes- Heat transfer and work transfer- Change in internal energy- throttling and free expansion- Second law of thermodynamics- Kelvin Plank statement and Classius statement and their equivalence, Corollaries- Perpetual motion machines of first kind and second kind- Reversibility and irreversibility- Cause of irreversibility- Carnot cycle- Heat engines and heat pumps- Carnet efficiency- Classius theorem- Classius inequality- Concept of entropy- Principles of increase of entropy- Entropy and disorder. Properties of steam and use of steam tables- Measurement of dryness fraction- T-S and H-S diagrams. Vapor Power Cycles: Vapor power cycle- Rankine cycle- Reheat cycle- Regenerative cycle- Thermodynamic variables effecting efficiency and output of Rankine and Regenerative cycles- Improvements of efficiency. Binary vapor power cycle.
Steam Nozzles: Steam Turbines: Classification of steam turbines- Impulse turbine and reaction turbine- Compounding in turbines- Velocity diagrams in impulse and reaction turbines- Degree of reaction- Condition for maximum efficiency of reaction turbines- Effect of friction on turbines constructional features governing of turbines. Condensers:

I.C. engines: classification, comparison of two stroke and four stroke engines, comparison of S.I. and C.I. engines. Air cycles- Otto, Diesel, Dual, Stirling, Ericson and Atkinson cycles and their analysis. Valve timing and port timing diagrams- Efficiencies- air standard efficiency, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency, volumetric efficiency and relative efficiency. Testing and performances of I.C. engines. Basic principles of carburetion and fuel injection. S.I. engines- Normal combustion and abnormal combustion- Importance of flame speed and effect of engine variables, types of abnormal combustion pre-ignition and knock, Fuel requirements and fuel rating, anti-knock additions- Combustion chamber requirements and Types of combustion chamber- Design principles of combustion chambers. C.I. engines- Stages of combustion- Delay period and its importance- effect of engine variables, diesel knock, suction compression and combustion induced turbulence, open and divided combustion chambers. Reciprocating compressors, effect of clearance volume in compressors, volumetric efficiency, single stage and multi stage compressors, effect of inter cooling in multi stage compressors. Vane type blower, centrifugal compressor- Adiabatic efficiency- Diffuser- Axial flow compressors- Velocity diagrams, degree of reaction, performance characteristics. Simple gas turbine plant- Ideal cycle, closed cycle and open cycle for gas turbines. Efficiency, work ratio and optimum pressure ratio for simple gas turbine cycle. Parameters of performance- Actual cycle, regeneration, Inter-cooling and reheating, closed and semi-closed cycle. Jet propulsion and Rockets.

Fluid Mechanics - Viscosity- Pressure measurement and Manometers- Hydrostatic forces on surfaces. Stream line- Stream tube- Stream function- Potential function- Classification of flows- Steady, Unsteady, Uniform, Non-uniform, Laminar, Turbulent, Rotational, Irrotational flows, Vorticity and circulation- Conservation of mass- Equation of continuity, Conservation of momentum- Euler's equation, Conservation of energy- Bernoulli's equation and its applications- Vortex motion- Free and forced vortices- Basic solutions of ideal fluid flows- Flow net analysis.

Couette flow- Plane Couette flow, Favourable pressure gradient and adverse pressure gradient- Flow through pipes- Hagen Poiseulle flow- Fannigs friction factor- Darcy's Weisbach friction factor- Loss of head due to friction in pipes- Laminar and turbulent regimes- Flow potential and flow resistance- Flow through branched pipes, Momentum equation- Forces due to pipe bends, Curved tubes, Sudden enlargement, Sudden contraction, flow through porous media- Darcy's equation. Two dimensional viscous flow: Navier -Stokes equations and solutions- Order of magnitude analysis- Boundary layer equations. Momentum integral equation- Flow over a flat plate- Displacement thickness, Momentum thickness and energy thickness. Laminar- Turbulent transition- Momentum equations and Reynold's stresses- Fully developed turbulent flow through a pipe- Turbulent boundary layer on a flat plate- Laminar sub-layer- Boundary layer separation and control. Fundamental and derived dimensions- Dimensionless groups- Buckingham p-theorem- Rayleigh method- Model testing- Types of similarity- Geometric, Kinematic and Dynamic similarities- Hydraulic diameter.

Marine Pollution

Ocean pollution: kinds and quantities of pollutants entering oceans - ocean dumping - fate of pollutants - toxic effects and nuclear waste disposal, Sources and Effects of Marine Pollution.

Oil spills, Fate of spilled oil; Treatment of oil at sea; disposal of oil platforms and other structures at sea, accomplishments and case studies towards reducing pollutant/contaminant inputs to the ocean. Aerial observation of oil; Beach cleaning; Environmental impact; Net Environmental Benefit Analysis; Public health risks and commercial damage; Case Studies

Plastics in the marine environment - Nature of plastic materials - Potential plastic pollutants - Distribution and impact of plastics - Trace metals as pollutants - Factors influencing the toxicity of trace metals to marine organisms – Case studies of marine pollution with reference to Mercury, Cadmium, etc.

Harmful Algae Bloom: Definition; Causative organisms; Impact; Relation with Eutrophication; In-situ treatment; Case Studies, Pollution by sewage and nutrients - discharges by rivers and estuaries - piped outfalls to the sea - sewage and micro-organisms - Disposal of persistent organic compounds - Effects of persistent organic compounds on marine organisms. How to address the Marine Pollution

IMO and regulatory mechanism to check pollution: Elementary treatment only.

Books Recommended

1. Clark, R.B. “Marine Pollution”, 5th Edition, Oxford University Press, 2001
2. Marine Pollution by Sebastian A. Gerlach, Springer Verlag
3. Fluid Mechanics, by A.K.Mohanty, Prentice Hall of India Pvt.Ltd.
4. Fluid Mechanics and Hydraulic Machines, by R.K.Bansal, Laxmi publications.
5. Engineering Thermodynamics, by P.K.Nag, Tata McGraw Hill Publications company.
6. Thermodynamics (SI Version) by William Z Black & James G Hartley
7. Thermal Engineering, by M.L.Mathur and F.S.Mehta, Jain Brothers.

Model Question Paper for Qualifying Examination for PhD Submission

(Marine Thermal Group)

Answer Any 5 Questions *All Questions carry Equal marks*

Maximum Marks = 100 *Time = 3 hrs*

1. Explain the following: First law and second law of thermodynamics, Steam power cycle with regeneration, Comparisons between impulse and reaction turbines, Compounding of steam turbines
2. Evaluate the non-flow work of a gas undergoing a reversible process in terms of P, V, and P-V according to the following relationships: $(a)\ P = c;\ (b)\ V = c;\ c)\ PV = C;\ (d)\ PV^{\gamma} = c$. Determine the quantities of work if initial pressure and volume are 5 bar and 5 m and final volume is 25 m .
3. State Buckingham's π -theorem. Why this theorem is considered superior over the Rayleigh's method for dimensional analysis. The resistance R, to the motion of a completely sub-merged body depends upon e length of the body L, velocity of flow V, mass density of fluid υ and kinematic viscosity of fluid V by dimensional analysis prove that $R = \rho V^2\ L^2\ \phi(VL/\upsilon)$
4. Air at 1.0 bar and 288 K enters an axial flow compressor with an axial velocity of 150 m/s. There are no inlet guide vanes. The rotor stage has a tip diameter of 60 cm and a hub diameter of 50 cm and rotates at 100rps. The air enters the rotor and leaves the stator in the axial direction with no change in velocity or radius. The air is turned through 30.2^0 as it passes through the rotor. Assume a stage pressure ratio of 1.2 and overall pressure ratio of 6. Find a) the mass flow rate of air, b) the power required to drive the compressor, c) the degree of reaction at the mean diameter, d) the number of compressor stages required if the isentropic efficiency is 0.85.
5. Write short notes on: Fate of pollutants in marine pollution Environmental impact, public health risk & commercial damage due to oil spill in oceans. Sewage and Micro-organisms.
6. Explain the three modes of heat transfer with examples.
7. a) State Newton's equation of viscosity and give examples of its application. Explain the importance of viscosity in fluid motion. What is the effect of temperature on viscosity of water and that of air? Distinguish between ideal fluids and real fluids. Explain the importance of compressibility in fluid flow.

b) An oil of viscosity 5 poise is used for lubrication between a shaft and sleeve. The diameter of shaft is 0.5 m and it rotates at 200 rpm. Calculate the horse power lost in the oil for a sleeve length of 100 mm. The thickness of the oil film is 1.0 mm.

8. How are IC engines classified. Explain in detail.

b)Explain the terms knocking, supercharging, detonation, pre ignition and scavenging.