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

Engineering Mechanics: Coplanar forces, Cartesian Vectors, equilibrium of a particle, Three-dimensional force systems Moment of a force, resultants of a force and couple system, distributed loading Conditions for equilibrium of a rigid body, equilibrium in 3-D, Simple Trusses, frames and machines Characteristics of dry friction wedges, screws, flat belts Centre of gravity, composite bodies, pappus Guldinus theorem, MI, MI of composite areas, product of inertia, Mass MI Principle of VW. Rectilinear Kinematics: Curvilinear Motion: Motion of a Projectile. Normal and Tangential Components. **Cylindrical Components. Absolute Dependent Motion Analysis of Two Particles. Newton's Law of Motion** Normal and Tangential Coordinates. Cylindrical Coordinates. Principle of Work and Energy. Principle of Linear Impulse and Momentum, Angular Momentum. Angular Impulse and Momentum Rotation About a Fixed Axis. Absolute General Plane Motion Analysis.

Solid mechanics

Stress, strain, lateral strain, stress-strain diagram. Generalisation of Hooke's law. Temperature stresses. Stresses in axially loaded bars. Strain energy Impact loads. Relation between elastic constants. Stress transformation: Transformation of stresses in 2-D problems. Principal stresses in 2-d problems. Maximum shear stresses in 2-d problems. Mohr's circle for stress transformation and principal stresses. Bending moments and shear forces: Types of beams, Types of loads, Types of supports S.F. and B.M. diagrams for statically determinate beams. Relation between bending moment , shear stress and intensity of loading. Stresses in beams: Simple theory of bending, Flexural formula, Shear stress in beams. Principal stresses in beams. Strain energy due to bending. Deflection of beams: Torsional stresses in shafts: Combined bending and torsion. Principal stresses in shafts. Strain energy due to twisting. Closed and opened coiled helical springs: Analysis of principal stresses in open and closed coiled helical springs. Thin walled cylindrical and spherical vessels: Analysis of stresses and strains.

Theory of Machines

Degrees of freedom; Classification of kinematic pairs Four-link mechanism; Velocity images; Angular velocity of links Instantaneous center (I-center); Acceleration, Coriolis acceleration component Turning moment on crankshaft, Flywheels. Gears and Gear Trains, Law of gearing-Velocity of sliding of teeth, forms of teeth- Length of contact, arc of contact, interference in involute gears, Types of gear trains- Simple, compound, reverted and epicyclic gear trains- Velocity ratio of epicyclic gear train- Balancing of a single rotating mass, several masses revolving in different planes- Primary and secondary unbalanced forces of reciprocating masses, Vibrations- Natural frequencies of free longitudinal vibrations of systems having single degree of freedom- Equilibrium method- Energy method and Rayleghy's method. Frequency of damped vibration and forced vibration with damping- Magnification factor or dynamic magnifier.

Manufacturing Processes

Foundry tools and appliances, layout – pattern types, materials, allowances, pattern making, moulding sands, types. Moulding methods, equipment for moulding, casting methods

Lathe, Working principle, classification, specification, different operations on a lathe, methods of taper turning, cutting speed, feed, depth of cut, machining time and power required for cutting. Turret and capstan lathes. quick return mechanisms, table feed mechanism working on shaper and planer, a comparison. Work holding devices. CNC machines

Books Recommended

1.   R C Hibbeler, Ashok Gupta, "Engineering Mechanics – Statics and Dynamics," 11th Edition, Pearson Education

2. *Vector Mechanics for Engineers: Statics and Dynamics*, by Ferdinand P. Beer & E. Russell Johnston Jr., McGraw Hill
3. *Engineering Mechanics* by S. P. Timoshenko and D.H.Young, Mc.Graw-Hill.
4. *Engineering Mechanics Statics and Dynamics* 4thed Irving H Shames, Prentice Hall
5. Engineering mechanics of solids by E.P.Popov,second edition ,PHI.
6. Mechanics of solids by R.C.Hibbler.
7. Analysis of structures by Vazairani and RatwaniVol 1,1993 edition.
8. Theory of Machines by R.S.Khurmi & J.K.Gupta
9. Theory of Machines by Thomas Bevan.
10. Theory of Machines by S.S. Rattan.
11. Engineering Metrology by R.K. Jain
12. Production Technology by R.K. Jain and S.C. Gupta
13. Production Technology by P.C. Sharma
14. Workshop Technology, Vol.1, 2&3 by W.A.J. Chapman
15. Machine Tools by Bhattacharya

Model Question Paper for Qualifying Examination for **PhD Submission**
(Marine Structural Group)
Answer Any 5 Questions
All Questions carry Equal marks

*Maximum Marks = 100*   *Time = 3 hrs*

1. The 100-kg stone is being dragged across the smooth surface by means of the truck T. If the towing cable passes over a smooth pulley at A, determine the speed of the stone when $\theta = 60^o$. The stone is at rest when $\theta = 30^o$, and the truck exerts a constant force F = 500 N on the cable at B.
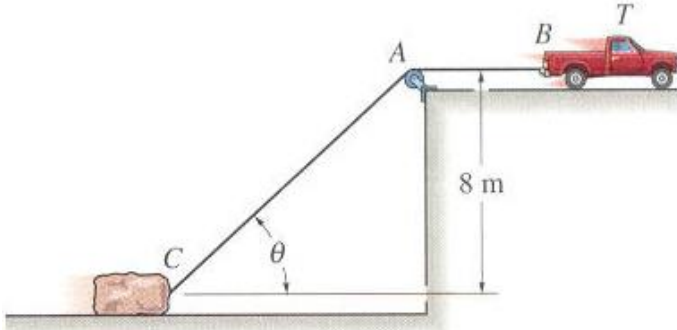
2. If the resultant moment about point A is 4800 N . m clockwise, determine the magnitude of F_3 if F_1 = 300 N and F_2 = 400N.
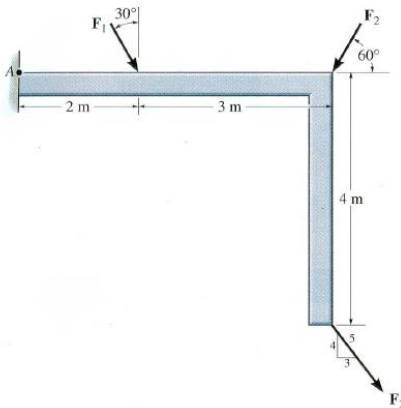
3. a) Distinguish between a shaper and planning machine.
   b) explain the working of the quick return mechanism of a shaper
4. A spherical gas tank has an inner radius of 1.5m. If it is subjected to an internal pressure of 300 kPa determine its required thickness if the maximum normal stress is not to exceed 12 MPa
5. A large window is opened using a hydraulic cylinder AB. If the cylinder extends at a constant rate of 0.5 m/s, determine the angular velocity and angular acceleration of the window at the instant $\theta = 30^o$.
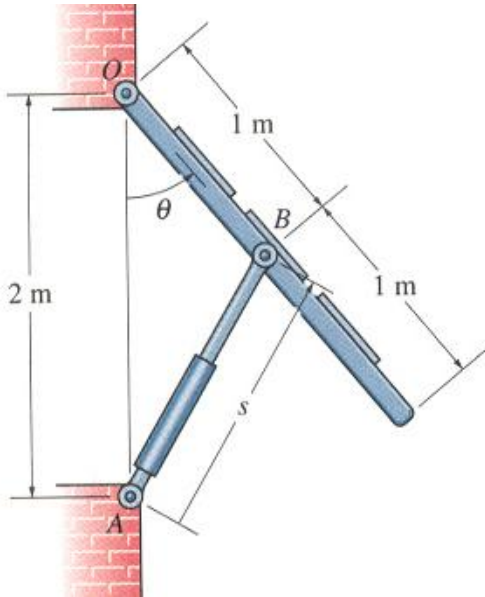
6.   The table of a CNC machine is driven by a Lead screw which is rotated servomotor. A digital encoder which emits 1000 pulses per second is mounted on the lead screw as a feedback device. If the lead screw pitch is 6 mm and motor rotates at 500 rpm, find 1. Basic Length Unit (BLU) of the system.   2. Linear velocity of the table. 3. Frequency of pulses generated by the feedback device.   10

7.   A two-cylinder uncoupled locomotive has inside cylinders 70 cm apart, the cranks are at right angles and are each 0.3 m long. The mass of the revolving parts per cylinder is 160 kg and the mass of the reciprocating engine is 180 kg .The whole of the revolving and the two thirds of the reciprocating parts are to be balanced and the balance masses are to be placed in the planes of rotation of the driving wheels at radius of 80 cm .The driving wheels are diameter and 1.5 m apart.   Find the magnitude and position of the balance masses. The driving crank speed is 300 r.p.m.

8.   A cylindrical riser of dia. 'd', height 'h' is situated at the top of casting and casting is of close type sand mold. Assume riser has constant volume, for the least rate of solidification determine the ratio h : d