CBCS SCHEME

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15ME51

Fifth Semester B.E. Degree Examination, July/August 2021
Management and Engineering Economics

Time: 3 hrs. Max. Marks: 80

Note: *1. Answer any FIVE full questions.*
2. Use of Interest factors table is permitted.

1 a. What are the various levels of management? Explain in brief. **(08 Marks)**
b. Explain the three important roles of manager. **(08 Marks)**

2 a. Discuss the importance of planning and briefly explain the hierarchy of plans. **(08 Marks)**
b. What is Decision making? What are its objectives? **(08 Marks)**

3 a. What is organizing? What are the various types of organization? **(08 Marks)**
b. Briefly explain the following:
i) Centralization v/s decentralization
ii) MBO and MBE. **(08 Marks)**

4 a. What is Motivation? Explain MC Gregor's theory X and theory Y of motivation? **(08 Marks)**
b. What is coordination? Briefly explain the importance and techniques of coordination. **(08 Marks)**

5 a. Explain in brief "Problem solving procedure" in engineering economics. **(06 Marks)**
b. Explain the following:
i) Price elasticity of demand
ii) Income elasticity of demand. **(10 Marks)**

6 a. Define Interest. Explain effective rate of interest and nominal rate of interest. **(08 Marks)**
b. A person avails a loan of Rs.10,000/- from a bank at an interest rate of 12% per annum. Find the amount to be repaid in 5 years if the interest is compounded.
i) Annually ii) Semiannually iii) Quarterly iv) Monthly. **(08 Marks)**

7 a. What are the conditions for present worth method of comparison of alternatives? Explain. **(06 Marks)**
b. An investor can make 3 end of year payments of Rs.15000/- which are expected to generate receipts of Rs.10000/- at the end of year 4, that will increase annually by Rs.2500/- for the following 4 years. Find the present worth of this investment at 10% interest. Use CFD for your analysis. **(10 Marks)**

8 a. What is equivalent annual worth method of comparison of alternatives? What is its advantage? **(06 Marks)**
b. A parcel of land adjacent to a proposed highway exist is deemed likely to increase in value. It can be purchased now for Rs.80000/- and is expected to be worth Rs.150,000/- (1.5 lakhs) in 5 years. During that period it can be rented for pasture at Rs.1500/year. Annual taxes are presently at Rs.850/year and will likely to remain constant. What rate of return will be earned on this investment? **(10 Marks)**

9 a. With the help of a chart/block diagram, explain the various elements of cost. **(07 Marks)**

b. A small firm is producing 100 pens per day. The direct material cost is found to be Rs.160/-, direct labour cost is Rs.200/- and factory overheads to it are Rs.250/-. If the selling and distribution expenses are 40% of the factory cost, what must be the selling price of each pen to realize a profit of 14.6% of the selling price? **(09 Marks)**

10 a. Define Depreciation. What are the various causes of depreciation? **(07 Marks)**

b. Find the depreciation amount during 5^{th} year and book value at the end of 8^{th} year using

i) Straight line method

ii) Declining balance method

iii) Sum of the years digits method, for a machinery with an initial cost of Rs.1,50,000/- and a salvage value of Rs.10,000/- after a service life of 10 years. **(09 Marks)**

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15ME52

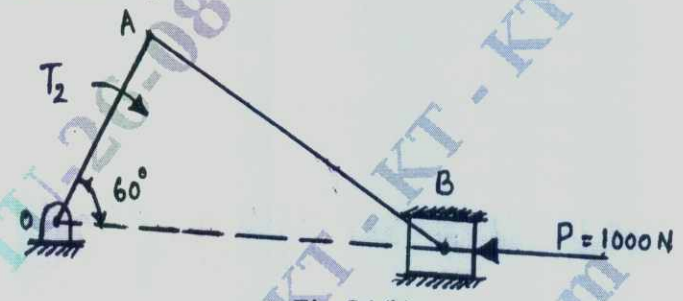
Fifth Semester B.E. Degree Examination, July/August 2021
Dynamics of Machinery

Time: 3 hrs. Max. Marks: 80

Note: *Answer any FIVE full questions.*

1 a. State the conditions for the equilibrium of the following systems :
   i) Two force member
   ii) Three force member
   iii) Member with two forces and a torque **(06 Marks)**

b. Determine the driving torque T_2 on the crank of a slider crank mechanism shown in Fig Q1(b) for static equilibrium.



OA = 100mm
AB = 300mm

Fig Q1(b) **(10 Marks)**

2 a. State and explain D'Alembert's principle. **(08 Marks)**

b. When the crank is 45° from the inner dead centre on the down stroke, the effective steam pressure on the Piston of a vertical steam engine is 2.5 bars. The diameter of the cylinder = 0.75m, Stroke of the piston = 0.50m and length of the connecting rod = 1m. Determine the torque on the crank shaft, if the engine runs at 350rpm and the mass of the reciprocating parts is 200kg. **(08 Marks)**

3 a. Explain briefly Static and Dynamic balancing. **(04 Marks)**

b. A shaft carries four masses A, B, C and D of magnitude 200kg, 300kg, 400kg and 200kg respectively and revolving at radii 80mm, 70mm, 60mm and 80mm respectively. The distances from the plane A are 300mm, 400mm and 700mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. the distances between the planes A and X is 100mm, between X and Y is 400mm and between Y and D is 200mm. If the balancing masses revolve at a radius of 100mm, find their magnitudes and angular positions. **(12 Marks)**

4 a. With usual notations, explain the primary and secondary unbalanced forces of reciprocating masses. **(04 Marks)**

b. A four crank engine has two outer cranks set at 120° to each other and their reciprocating masses are each 400kg. The distance between planes of rotation of adjacent cranks are 450mm, 750mm and 600mm. If the engine is to be in complete primary balance, find the reciprocating mass and the relative angular position for each of the inner cranks. If the length of each crank is 300mm, the length of each connecting rod is 1.2m and the speed of rotation is 240rpm, find the maximum secondary unbalanced force. **(12 Marks)**

5 a. Derive an expression for the Gyroscopic couple C = I. ω. ω_p. **(06 Marks)**

b. In a spring loaded Hartnell governor the extreme radii of rotation of the balls are 80mm and 120mm. The balls arm and sleeve arm of the bell crank lever are equal in length. The mass of each ball is 2kg. If the speeds at the two extreme positions are 400rpm and 420 rpm. Find:
   i) Spring stiffness
   ii) Initial compression of the central spring
   iii) Sleeve lift. **(10 Marks)**

6 a. Define :
   i) Sensitiveness
   ii) Stable Governor
   iii) Governor power **(06 Marks)**

b. The rotor of the turbine of a ship has a mass of 5000kg and rotates at a speed of 2100rpm clockwise when viewed from stern. The rotor has a radius of gyration 0.5m. Determine the gyroscopic couple and its effect when,
   i) The ship steers to the left in a curve of 60m radius at a speed of 16 knots (1 knot = 1860m/hr)
   ii) The ship pitches 6° above and 6° below the horizontal position and the bow is descending with its maximum velocity. The pitching motion is simple harmonic with a periodic time of 20 seconds
   iii) The ship rolls and at that instant the angular velocity is 0.03 rad/sec clockwise when viewed from the stern. **(10 Marks)**

7 a. Define the following terms :
   i) Natural frequency
   ii) Degrees of freedom
   iii) Resonance
   iv) Free and forced vibrations
   v) Damped and undamped vibrations **(10 Marks)**

b. Add the following motions analytically
   $x_1 = 3 \sin(wt + 30°)$, $x_2 = 4 \cos(wt + 10°)$ **(06 Marks)**

8 a. Derive the differential equation of a spring mass system using Newton's and Energy method. **(08 Marks)**

b. Two masses m_1 and m_2 are connected to the rod as shown in Fig Q8(b). Determine the natural frequency of the system.

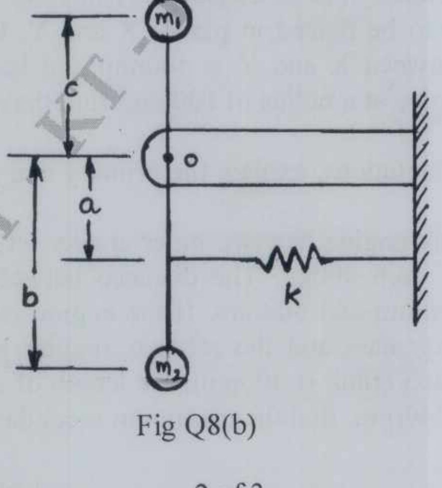


Fig Q8(b) **(08 Marks)**

9 a. Define logarithmic decrement. Show that logarithmic decrement δ is given by $\frac{2\pi\xi}{\sqrt{1-\xi^2}}$ for underdamped system. **(06 Marks)**

b. A spring mass damper system has m = 3kg, k = 100N/m, c = 3 N-sec/m. Determine :
   i) Damping factor
   ii) Natural frequency of damped vibration
   iii) Logarithmic decrement
   iv) The ratio of two successive amplitudes
   v) Number of cycles after which the original amplitude is below 20% **(10 Marks)**

10 a. Show that providing damping in vibration isolation is not useful when the frequency ratio is more than $\sqrt{2}$ or 1.44. **(06 Marks)**

b. A machine of total mass 17kg is mounted on springs having stiffness K = 11 × 10^5N/m. A Piston within the machine has a mass of 2kg has a reciprocating motion with stroke 7.5cm and speed 6,000rpm. Assuming the motion to be S.H.M. Determine :
   i) Maximum amplitude of vibration
   ii) Transmissibility
   iii) Force transmitted to the ground or foundation.
   Take ξ = 0.2. **(10 Marks)**

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15ME53

Fifth Semester B.E. Degree Examination, July/August 2021
Turbo Machines

Time: 3 hrs. Max. Marks: 80

Note: 1. ***Answer any FIVE full questions.***
2. ***Use of Thermodynamics Data Hand Book, Steam tables and Mollier chart permitted.***

1 a. Define a turbo machine. Mention any five differences between a turbo machine and a positive displacement machine. **(06 Marks)**

b. Define specific speed of a turbine. Explain its significance. **(03 Marks)**

c. A Francis turbine model is built to a scale of 1 : 5. The data for the model is P = 6 kW, N = 350 rpm, H = 3 m and for prototype H = 9 m. Assuming the overall efficiency of the model as 75%, calculate :
(i) Speed of the prototype (ii) Power of the prototype.
Use Moody's equation. **(07 Marks)**

2 a. Show that the polytropic efficiency for a compression process is given by $\eta_P = \left(\frac{n}{n-1}\right)\left(\frac{\gamma-1}{\gamma}\right)$ where γ is the ratio of specific heats and n is the index of compression. **(08 Marks)**

b. Air flows through an air turbine where its stagnation pressure is decreased in the ratio 5 : 1. Total-to-Total efficiency is 0.8. The air flow rate is 5 kg/s. If the total power output is 500 kW, find : (i) Inlet total temperature (ii) Actual exit total temperature (iii) Actual exit static temperature if the flow velocity is 100 m/s. (iv) Total-to-static efficiency. **(08 Marks)**

3 a. Define degree of reaction. Show that the relationship between the utilization factor $\in$ and the degree of Reaction R for an axial flow turbine is given by $\in = \frac{V_1^2 - V_2^2}{V_1^2 - RV_2^2}$ where V_1 and V_2 are the absolute velocity of fluid at inlet and outlet respectively. **(08 Marks)**

b. At a stage in a 50% degree of reaction axial flow turbine running at 3000 rpm, the blade mean diameter is 68.5 cm. If the maximum utilization factor for the stage is 0.915, calculate the inlet and outlet absolute velocities for the rotor assuming the velocity triangles at inlet and outlet to be symmetric. Find also the power output for a flow rate of 15 kg/s. **(08 Marks)**

4 a. Draw the velocity triangles for an axial flow compressor and show that for an axial flow compressor with no axial thrust, the degree of reaction is given by $R = \frac{V_a}{2u}\left[\frac{\tan\beta_1 + \tan\beta_2}{\tan\beta_1 \tan\beta_2}\right]$
where V_a = Axial flow velocity, u = Blade speed, β_1 and β_2 = Inlet and Outlet blade angles with respect to tangential direction. **(10 Marks)**

b. In a mixed flow compressor handling air at 16000 rpm, the stagnation temperature of air at compressor inlet and outlet are respectively 27°C and 215°C. The absolute velocity of air at the rotor inlet is axial while at the exit, the tangential component of absolute velocity is 0.93 times the tangential impeller speed. If the mass flow rate of air through the impeller is 15 kg/s and specific heat is assumed to be constant, find the impeller diameter and total power input. **(06 Marks)**

5 a. What do you mean by compounding of steam turbine? Explain with the help of a schematic diagram, a two row velocity compounded turbine stage. **(06 Marks)**

b. A single stage impulse wheel is supplied with super heated steam at 15 bar and 250°C, expands to 0.5 bar condenser pressure. The rotors are fitted with equi angular blades moving at 450 m/s. If the nozzle angle at the rotor inlet is 16° to the wheel plane, find the specific power output, blade efficiency, grass stage efficiency and direction of exit steam velocity. Assume nozzle efficiency as 94% and assume the relative velocities as equal. **(10 Marks)**

6 a. Show that the maximum blade efficiency of a Parson's reaction turbine is,

$$(\eta_b)_{max} = \frac{2\cos^2 \alpha_1}{1+\cos^2 \alpha_1}$$

where α_1 = nozzle angle at inlet. **(09 Marks)**

b. The following particulars refer to a Parson's reaction turbine consisting of one ring of fixed blades and one ring of moving blades. The mean diameter of the blade ring is 90 cm and its speed is 3000 rpm. The inlet absolute velocity to the blades is 350 m/s. The blade outlet angle is 20°. The steam flow rate is 7.2 kg/s. Calculate (i) The blade inlet angle (ii) Tangential force (iii) Power developed. **(07 Marks)**

7 a. With suitable velocity triangles, derive an expression for the maximum hydraulic efficiency of a Pelton wheel in terms of blade velocity co-efficient and outlet blade angle. **(08 Marks)**

b. A 137 mm diameter jet of water issuing from a nozzle impinges on the buckets of a Pelton wheel and the jet is deflected through an angle of 165° by the buckets. The head available at the nozzle is 400 m. Assuming coefficient of velocity as 0.97, speed ratio as 0.46 and reduction in the relative velocity while passing through the buckets as 15%, find (i) Force exerted by the jet on the buckets in the tangential direction (ii) theoretical power developed. **(08 Marks)**

8 a. List the functions of a draft tube in a reaction hydraulic turbine. Using Bernoulli's equation, show that the pressure head at the inlet of the draft tube is less than the atmospheric pressure head. **(06 Marks)**

b. The following data is given for a Francis turbine : Net head = 70 m, Speed = 600 rpm, Shaft power = 368 kW, Overall efficiency = 85%, hydraulic efficiency = 95%, Flow ratio = 0.25, Breadth ratio = 0.1, Outer diameter of the runner = 2 × inner diameter of the runner. Velocity of flow is constant at inlet and outlet. The thickness of the vanes occupies 10% of the circumferential area of the runner and the discharge is radial at outlet. Determine : (i) Guide blade angle (ii) Runner vane angles at inlet and outlet. (iii) Diameter of runner at inlet and outlet (iv) Width of the runner at inlet. **(10 Marks)**

9 a. What is Priming? Why priming is required in centrifugal pumps? **(03 Marks)**

b. Derive an expression for minimum starting speed of a centrifugal pump. **(06 Marks)**

c. A 4-stage centrifugal pump has impellers each of 38 cm diameter and 1.9 cm wide at outlet. The outlet vane angle is 45° and the vanes occupy 8% of the outlet area. The manometric efficiency is 84% and overall efficiency is 75%. Determine the head generated by the pump when running at 900 rpm discharging 59 litres/s of water. Also determine the power required. **(07 Marks)**

10 a. Explain the following with appropriate sketches :
(i) Surging (ii) Choking (iii) Pre-rotation. **(09 Marks)**

b. A centrifugal compressor runs at a speed of 15000 rpm and delivers 30 kg/s of air. The exit diameter is 70 cm. The relative velocity at exit is 100 m/s at an exit blade angle of 75°. Assume radial inlet. The inlet total temperature and pressure are 300 K and 1 bar respectively. Determine :
(i) Power required to drive the compressor (ii) Ideal head developed
(iii) Total exit pressure. **(07 Marks)**

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15ME54

Fifth Semester B.E. Degree Examination, July/August 2021
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 80

Note: **1.** ***Answer any FIVE full questions.***
2. ***Use of design data hand book is permitted.***
3. ***Assume missing data, if any, suitably.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. Define Mechanical Engineering design. Explain phases of design with a neat block diagram. **(06 Marks)**

b. A hollow shaft of 40 mm outer diameter and 25 mm inner diameter is subjected to a twisting moment of 118 N-m, axial tensile load of 10 kN and a bending moment of 80 N-m. Calculate the maximum tensile and maximum shear stress. **(10 Marks)**

2 a. A grooved shaft shown in Fig.Q2(a) transmits 10 KW at 1000 rpm. Determine the diameter of the shaft at the groove. The permissible stress for the shaft material can be taken as 150 MPa.

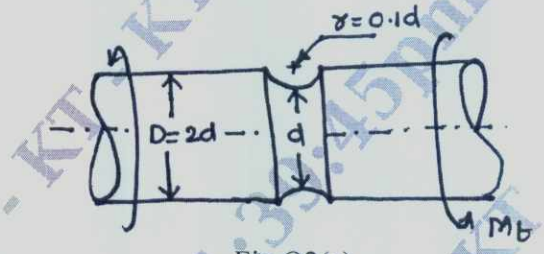

Fig.Q2(a) **(08 Marks)**

b. A link made of grey cast iron having a permissible stress of 100 MPa is subjected to a force of 25 kN as shown in Fig.Q2(b). Determine the dimensions of the cross-section of the link.

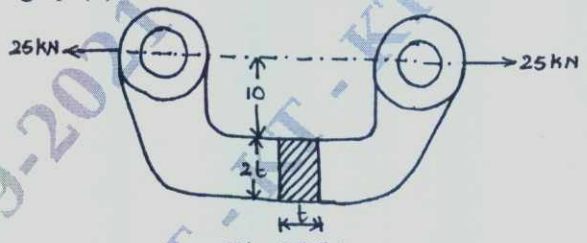

Fig.Q2(b) **(08 Marks)**

3 a. Derive an expression for impact stress in a axial bar of cross-section 'A' and length 'L' due to impact of a load 'W' falling from a height 'h'. **(08 Marks)**

b. A mass of 50 kg drops through 25 mm at the center of a 250 mm long simply supported beam. The beam has square cross-section having an allowable stress of 200 MPa. Determine the dimensions of the cross-section of the beam. Take E = 207 GPa. **(08 Marks)**

4 A round rod of diameter 1.2 d is reduced to a diameter 'd' with a fillet radius of 0.1d. The stepped rod is to sustain a twisting moment that fluctuates between +2.5 kN-m and +1.5 kN-m together with a bending moment that fluctuates between +1 kN-m and –1 kN-m. The rod is made of carbon steel C40 (σ_y = 328.6 MPa; σ_u = 620 MPa). Determine a suitable value for 'd'. **(16 Marks)**

5 A commercial steel shaft transmits 15 kW at 300 rpm. It is supported on two bearings 1.2 m apart. The shaft receives power through a 450 mm diameter pulley mounted at 300 mm to the right of right bearing. The power is given out through a 300 mm diameter gear mounted at 250 mm to the right of left bearing. The belt drive is horizontal and gear drive with a downward tangential force. Design the shaft. Allowable stress for the shaft with keyway is 40 MPa. Take $K_b = K_t = 1.5$ and ratio of belt tension = 3. **(16 Marks)**

6 Design a cast iron flange coupling to connect two shafts of 45 mm diameter to transmit 20 KW power at 400 rpm. The permissible shear strength for the shaft, bolt and the key is 50 MPa and the permissible compressive stress is 120 MPa. The permissible shear stress for cast iron is 15 MPa. Assume starting torque is 30 percent higher than the normal torque. Take keyway factor as 0.75. **(16 Marks)**

7 a. Design a double riveted butt joint with two cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm^2. Assume an efficiency of 75%, allowable tensile stress in the plate is 90 N/mm^2, allowable crushing stress of 140 N/mm^2 and an allowable shear stress in the rivet as 56 N/mm^2. **(08 Marks)**

b. Determine the load carrying capacity for the riveted joint shown in Fig.Q7(b). The allowable stress in the 20 mm diameter rivet is 100 N/mm^2.

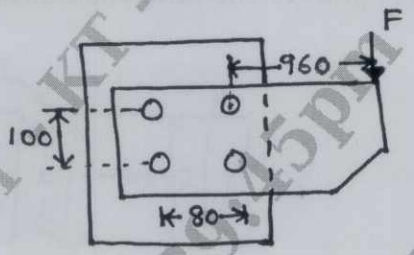

Fig.Q7(b) **(08 Marks)**

8 a. A welded joint shown in Fig.Q8(a) is subjected to an eccentric load of 2.5 kN. Find the size of the weld if maximum stress in the weld is 25 MPa.

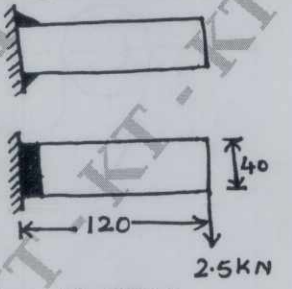

Fig.Q8(a) **(08 Marks)**

b. Find the size of the weld for a bracket loaded as shown in the Fig.Q8(b). The allowable stress for the weld may be taken as 75 MPa.

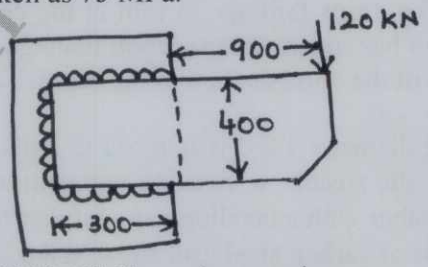

Fig.Q8(b) All dimensions are in mm **(08 Marks)**

9 a. A M10 steel bolt of 125 mm long is subjected to an impact load. The kinetic energy absorbed by the bolt is 2.5 J. Determine:

(i) Stress in the shank of the bolt if there is no threaded portion between the nut and the bolt head.

(ii) Stress in the shank if the area of the shank is reduced to that of the root area of the thread or the entire length of the bolt is threaded.

Take E = 206 GPa. **(08 Marks)**

b. A steel bracket subjected to a force of 10 kN and fixed to a channel is as shown in Fig.Q9(b). Determine the size of the bolt if the allowable shear stress in the material is 70 N/mm^2.

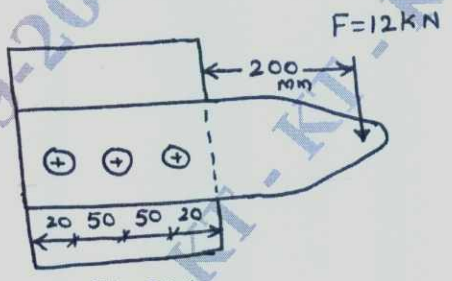

Fig.Q9(b) **(08 Marks)**

10 a. A split nut used with a lead screw is propelled at a speed of 5 m/min, against a load of 20 kN, along the spindle of a square thread (single start) having nominal diameter of 30 mm and pitch of 6 mm. The axial thrust is absorbed by a collar of 100 mm outside diameter and 70 mm inside diameter. Assuming suitable coefficient of friction, determine:

(i) Power required to drive

(ii) Height of bronze nut required if allowable bearing pressure is 17 MPa

(iii) Efficiency of the drive. **(08 Marks)**

b. A Sluice gate weighing 600 kN is raised and lowered by two 75 mm square threaded screw. The screws are operated by a 600 rpm motor. The coefficient of collar friction is 0.03 and coefficient of thread friction is 0.14. The outer diameter of the collar is 100 mm and inner diameter is 50 mm. The gate is to be raised at a rate of 0.6 m/min. Determine the power required to raise the gate. **(08 Marks)**

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