

Q. No. PH - 331 / 105

B. Tech./Odd
2017-18/Reg

2017-18

SEMICONDUCTOR PHYSICS

PH - 331

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Answer any *five* questions.

1. (a) Find an expression for the electron concentration at equilibrium in a semiconductor at a given temperature.
- (b) Make a comparison between direct and indirect bandgap semiconductors.
- (c) Discuss the properties of a hole. 8+3+3
2. (a) Show that the contact potential of a p-n junction is
$$V_0 = \frac{kT}{q} \ln \frac{N_a N_d}{n_i^2}$$
 where the symbols have their usual meanings.
- (b) Explain the phenomenon of diffusion of charge carriers in semiconductors. What is Einstein's relationship?
- (c) The room-temperature electron mobility in GaAs is $8000 \text{ cm}^2/\text{volt}/\text{sec}$. Calculate the diffusion constant for electrons. 8+3+3

3. (a) Discuss the working of a semiconductor laser. How does it differ from other lasers? What are its uses?

(b) What is LED? Discuss some of its applications.

10+4

4. (a) What is Meissner effect? Show that Meissner effect contradicts the Maxwell's equation.

(b) Discuss the BCS theory of superconductivity. Show that this theory provides adequate explanation of superconducting state.

4+10

5. What are the difference between the static and dynamic MOS RAM cell? Why dynamic RAM cannot operate below a minimum operating frequency? Explain the operation of three phase CCD.

3+3+8

6. What is device trans-conductance parameter? How it is related with gate oxide thickness of NMOS transistor? Draw and explain the input output relationship of CMOS device. Write short note on Enhancement and Depletion MOSFET.

1+2+4+7

7. What is midpoint voltage of CMOS device? What is the mode of operation of NMOS and PMOS at midpoint voltage? Deduce the expression of midpoint voltage. Deduce the necessary expression and calculate the output propagation low-to-high delay time for the following data $V_{DD} = 5V$, $K_N = 80 \mu A/V^2$, $K_P = 64 \mu A/V^2$, $V_{TN} = 1V$, $V_{TP} = -1 V$, $W_N / L_N = 4 \mu m / 2 \mu m$, $W_P / L_P = 8 \mu m / 2 \mu m$.

1+1+3+9

8. Write short note on static NMOS RAM cell and JFET.

7+7

085

Q. No. PH - 332 /

B. Tech./Odd

2017-18/Reg

2017-18

PHYSICS OF SEMICONDUCTOR DEVICES

PH - 332

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

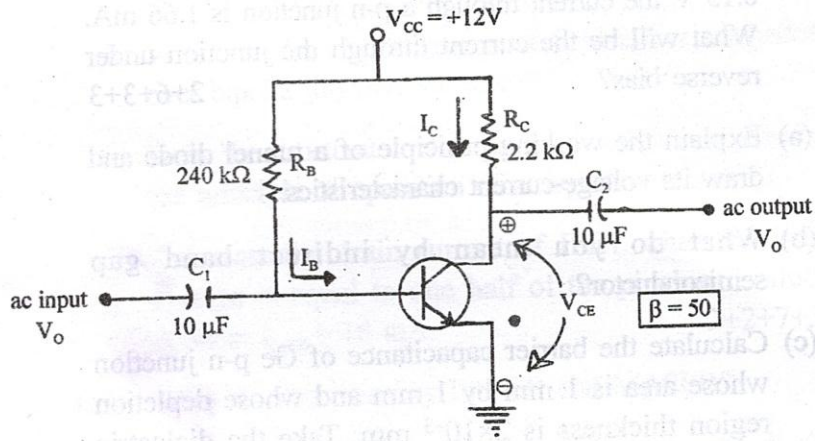
Answer any five questions.

1. (a) What do you mean by unipolar junction transistors and bipolar junction transistors?
(b) What are the advantageous of field effect transistor over bipolar junction transistor?
(c) Draw the structural configuration of NMOS and explain the principle of operation of a depletion MOSFET.
(d) Calculate the drain current of JFET when the gate voltage is equal to one half of the pinch-off value. Assume $I_{DSS} = 16 \text{ mA}$. 2+2+7+3
2. (a) What do you mean by LASER and MASER?
(b) Explain with schematic diagram how does a diode LASER work.
(c) Make a comparison of the output optical power vs drive current curve of a diode LASER and LED.
(d) What are the advantages and disadvantages of a semiconductor LASER? 2+7+2+3

P.T.O.

3. (a) Define effective mass and mobility of a hole.
- (b) Find out the expression for concentration of holes in the valance band in a semiconductors at equilibrium.
- (c) Write down the law of mass action for a semiconductor.
- (d) Mobility of electrons and holes in a sample of intrinsic germanium at 300 K are $0.36 \text{ m}^2\text{V}^{-1}\text{s}^{-1}$ and $0.17 \text{ m}^2\text{V}^{-1}\text{s}^{-1}$ respectively. If the conductivity of the specimen is $2012 \text{ } \Omega^{-1}\text{m}^{-1}$, compute the forbidden energy gap. 2+5+2+5
4. (a) What do you mean by density of states?
- (b) Write down an expression for the average number of fermions in a single-particle state.
- (c) Write a short note on Hall effects' of semiconductor.
- (d) A semiconducting crystal of 12 mm long, 5 mm wide and 1 mm thick has a magnetic flux density of 0.5 weber/m^2 applied from front to back perpendicular to the largest faces. When a current of 20 mA flows lengthwise through the specimen, the voltage measured across its width is found to be $37 \text{ } \mu\text{V}$. What is the Hall coefficient of this semiconductor? Estimate what the above voltage ($37 \text{ } \mu\text{V}$) would have if a specimen of copper of similar dimensions and with the same 20 mA current flowing along its length, had been placed in the same field. 2+2+4+6
5. (a) Write a short note on Silicon Controlled Rectifier (SCR).

- (b) Draw the I-V characteristic of a solar cell and explain its principle of operation.
- (c) Find the static and the dynamic resistance of a p-n junction germanium diode if the temperature is 27°C and $I_0 = 1 \mu\text{A}$ for an applied forward bias of 0.2 V.
4+4+6
6. (a) Determine the following for the fixed bias configuration of the circuit given below (i) I_B & I_C , (ii) V_{CE} , (iii) V_B & V_C and (iv) V_{BC} . [The notations of all the parameters stands for their usual meaning for a transistor]



- (b) What do you mean by Gunn Effect?
- (c) Draw the characteristic curves of Gunn diode and explain its different regions.
10+2+2

P.T.O.

7. (a) What do you mean by drift current and diffusion current in a p-n junction?
- (b) Graphically show the variation of energy (E) with (i) density of states $[N(E)]$, (ii) Fermi-Dirac distribution function $[F(E)]$ and (iii) carrier concentration $[n(E)]$ in (A) intrinsic, (B) n-type (C) p-type semiconductors at thermal equilibrium. Clearly depict the position of bottom of the conduction band, top of the valence band and Fermi level in each plot.
- (c) Graphically show the variation of carrier concentration with temperature in Ge, Si and GaAs semiconductors.
- (d) At room temperature under the forward bias of 0.15 V the current through a p-n junction is 1.66 mA. What will be the current through the junction under reverse bias? 2+6+3+3
8. (a) Explain the working principle of a tunnel diode and draw its voltage-current characteristics.
- (b) What do you mean by indirect band gap semiconductor?
- (c) Calculate the barrier capacitance of Ge p-n junction whose area is 1 mm by 1 mm and whose depletion region thickness is 2×10^{-3} mm. Take the dielectric constant of Ge as 16.
- (d) Write a short note on Read-only memories. 6+1+2+5

Q. No. PH - 333 / 102

B. Tech./Odd
2017-18/Reg

2017-18

QUANTUM PHYSICS

PH - 333

Full Marks : 70

Time : Three Hours

The figures in the margin indicate full marks.

Symbols are in their usual meaning.

Answer any *five* questions.

1. What do you mean by Compton effect? Derive an expression of the Compton shift $\Delta\lambda$ with the help of quantum theory. A 0.75 MeV photon is scattered at an angle of 60° . Find the energy of the recoil electron. Deduce the formula you use. Take electronic rest mass = 0.5 MeV. 2+6+6
2. (a) What is photoelectric effect? Write down the characteristics of photoelectric effect and explain these by using quantum theory of radiation.
(b) State Heisenberg's uncertainty principle. Prove that the free electrons cannot exist inside the nucleus. 2+3+3+2+4
3. Define Ladder operators J_+ and J_- . Derive the commutation relation between J_+ and J_- . Find the Eigen value of J_+ and calculate the matrix form of J_+ for $J = 1$. 3+3+3+5

P.T.O.

(2)

4. (a) Define identity operator and null operator. Derive the commutation relation between position and momentum operator.
- (b) Show that the two wave functions will be orthogonal if they are operated by the same hermitian operator with two different Eigen values.
- (c) Define hermitian operator. Prove that the momentum operator $-i\hbar\partial/\partial x$ is hermitian. 2+3+4+1+4
5. (a) Write down the physical significance of the wave function. Derive the time dependent Schrodinger wave equation.
- (b) The wave function of a particle confined to a box of length 'a' is

$$\varphi(x) = \left(\frac{2}{a}\right)^{1/2} \sin \frac{\pi x}{a} \quad \text{for } 0 < x < a$$

= 0 everywhere else

Calculate the probability of finding the particle in the region $0 < x < a/2$.

- (c) The ground state of a single electron in an atom with a nuclear charge Ze is

$$\psi(r) = 2\left(\frac{Z}{a_0}\right)^{3/2} \exp\left(-\frac{Zr}{a_0}\right)$$

where a_0 is the Bohr radius. Calculate the expectation value of the distance of the electron from the nucleus.

2+4+4+4

(3)

6. (a) What do you mean by degeneracy of the energy level? Determine the degree of degeneracy of the energy level $38\left(\frac{h^2}{8ma^2}\right)$ of the particle in a cubical potential box of side 'a'.
- (b) Define Eigen value and Eigen vector of an operator. Three unit mass points are located in such a way that the matrix form of moment of inertia operator is given by

$$\hat{I} = \begin{pmatrix} 10 & 0 & 0 \\ 0 & 6 & -4 \\ 0 & -4 & 6 \end{pmatrix}$$

Find the Eigen values and mutually orthogonal Eigen vectors. 1+4+2+7

7. Define Pauli spin matrix and derive their matrix form. Find the commutation relations among them. Derive the normalized wave functions of operators σ_x , σ_y and σ_z for electron of spin $S = 1/2$. 2+5+3+4
8. Derive components of angular momentum (J) in spherical polar co-ordinates. Calculate the Eigen values of L^2 and L_z and determine the matrix form of L^2 for the spin $S = 3/2$. 5+6+3

Q. No. PH 543 / 073

B.Tech / Odd
(17-18) / Reg

2017-18

THIN-FILM TECHNOLOGY

PH 543

Full Marks : 70

Time : 3 hours

The figures in the margin indicate full marks.

Answer any *five* questions.

1. Describe the construction of MBE chamber and fabrication of epitaxial film. What is RHEED technique ? Find the lattice mismatch between GaN and Al₂O₃. It is given that the lattice constant of GaN = 3.189 Å and Al₂O₃ = 4.765 Å 6 + 4 + 4
2. Explain the Langmuir-Blodgett method for the layer by layer growth of film. Point out the advantages and disadvantages of the procedure over MBE method. Explain synthesis of SiO₂ thin film by CVD method. 6 + 4 + 4
3. Describe the working principle of X-ray diffraction method for the crystal structure determination of material. What is GXR ? Why it is important for thin film technology ? The spacing between principal planes of GaAs thin film is 0.28 nm. If, first order Bragg reflection occurs at an angle of 10°, then what is the wavelength of the used X-ray ? 6 + 2 + 2
4. Describe PL measurement technique for determination of band gap of a thin film. Discuss the optical absorption process for the thin film. GaN thin film is excited with 325 nm

wavelength. The film produced emission at 420 nm. What is the band gap of GaN ?

6 + 5 + 3

5. Discuss the construction of SEM instrument and working principle of SEM. Explain the determination of surface morphology of thin film using STM. Find out the wavelength of the electron beam emitted from the cathode with bias voltage of 100 KeV. Given that the mass of the electron is $= 9.10938356 \times 10^{-31}$ kilograms and Planck's constant $h = 6.62607004 \times 10^{-34}$ m²kg/s.
6. Describe about the construction of TEM instrument. How we can determine the crystal structure of materials by TEM. The concentric rings of radius 5 cm obtained in SAED analysis. The camera constant is 1 A°, determine the d spacing of the material.
7. Describe the working principle of DC and Magnetron sputtering. What is the advantages of Magnetron sputtering over DC sputtering ? Describe thin film fabrication by laser ablation method. An electron is moving with velocity v in the perpendicular magnetic field $B = 10^3$ Gauss. Find out the radius of the circular path that will be traced by the electron.
8. Describe photocurrent measurement of a Schottky diode. Write down working principle of solar cell and establish the formula for external quantum efficiency. Determine the power conversion efficiency of a solar cell. Given that the short circuit current is 100 mA, the open circuit voltage is 0.3 V and the power of the incident light is 50 W.

5 + 6 + 3

158

Q. No. PHC - 01 /

B. Tech./Odd
2017-18/Reg

2017-18

PHYSICS

PHC - 01

Full Marks : 50

Time : Three Hours

The figures in the margin indicate full marks.

Answer all parts of a question together.

Question No. 1 is compulsory. Answer any other *four* questions.

1. Answer any *five* : 2×5

- (a) The displacement of a moving particle at any time t is given by $x = A \cos \omega t + B \sin \omega t$. Show that the motion is simple harmonic.
- (b) What is relaxation time and how does it vary with damping coefficient ?
- (c) Find the wavelength of the waves associated with an electron having energy equal to 1 MeV.
- (d) What do you mean by fringes of constant thickness and inclination ? Give examples.
- (e) What is the difference between Fresnel and Fraunhofer diffraction ?
- (f) What do you mean by optic axis of a crystal ? Explain double reflection.

P.T.O.

2. (a) Two perpendicular harmonic oscillations are described by the equations :

$$x = A_1 \cos \omega t, \quad y = A_2 \cos(2\omega t + \delta).$$

If these two harmonic oscillations act upon a particle simultaneously show that the resulting path represents two coincident parabolas for $\delta = 0$.

- (b) Show that the average energy of a weakly damped harmonic oscillator decays exponentially with time.

5+5

3. (a) Set up the differential equation of motion of a simple harmonic oscillator subjected to a damping force and an external simple harmonic force. Obtain expressions for the amplitude and phase angle of the displacement in the steady state.

- (b) The amplitude of a forced oscillator at frequencies 300/s and 500/s are equal. What is the value of the resonant frequency ?

7+3

4. (a) State and explain Heisenberg's uncertainty principle.

- (b) Using the formulations of Schroedinger, show that the energy of a particle inside a box is quantized.

2+8

5. What is diffraction grating ? Deduce the intensity expression due to the grating diffraction. What do you mean by absent spectra ? A parallel beam of light is normally incident on a plane transmission grating having 4250 lines per cm and a second order spectral line is obtained at an angle 30° . Calculate the wavelength of light.

1+5+2+2

6. What do you mean by polarised light and unpolarised light ? Explain the terms 'plane of polarisation' and 'plane of vibration'. State and explain Malus's law. Analytically prove that the optical disturbances

$$E_x = E_{0x} \sin\left(kz - \omega t + \frac{\pi}{3}\right) \quad \text{and} \quad E_y = E_{0y} \sin(kz - \omega t)$$

represent an elliptical wave.

2+2+3+3

7. Define the terms 'spontaneous' and 'stimulated' emission of light and 'population inversion'. Explain the construction and working principle of He-Ne LASER. A silicon optical fiber having core refracting index of 1.50 and a cladding refractive index of 1.47. Determine the critical angle at the core-cladding interface, numerical aperture (NA) and the acceptance angle in air for the fiber.

3+4+3

Q. No. XE 541/ 091

2017-18

B.Tech / Odd
17-18 / Reg

LEADERSHIP AND ENTREPRENEURSHIP

XE 541

Full Marks : 70

Time : 3 hours

Answer Q. No. 1 & 7 and any *two* from the rest.

1. (a) What are the mistakes of entrepreneurship?
(b) How does one create a high level organization?
(c) How do the pricing of a commodity affect the business proposals?
(d) How does communication helps to grow up as a leader?
(e) How does time acts as a stress for human beings?
15
2. What are the four pertinent questions of leadership ?
Illustrate with examples from your life. Do leaders create followers ? Justify with respect to nature of students in an engineering college. 10
3. Outline the steps involved in developing a cash budget.
What are the steps taken by entrepreneur to conserve cash within their companies? 10
4. Explain the following terms: effortless effort; knot process; transformation ; vision. How do a person grow up inculcating values? 10
5. What are the 4 P's of marketing? What is marketing mix?
What are the principles of Pricing of a commodity? 10

(G/49-100)

(Turn over)

6. Mention the various modes of relationship marketing process. Elaborate balance scorecard with an example.

10

7. Analyse the following case studies and answer the questions that follow.: (any five) $5 \times 7 = 35$

(a) When St. Petersburg, one of the most splendid, harmonious cities in Europe, was being laid out early in the eighteenth century, many large boulders brought by a glacier from Finland had to be removed. One particularly large rock was in the path of one of the principal avenues that had been planned, and bids were solicited for its removal. The bids submitted were very high. This was understandable, because at that time modern equipment did not exist and there were no high powered explosives. As officials pondered what to do, a peasant presented himself and offered to get rid of the boulder for a much lower price than those submitted by other bidders. Since they had nothing to lose, officials gave the job to the peasant.

The next morning he showed up with a crowd of other peasants carrying shovels. They began digging a huge hole next to the rock. They propped up the rock with timbers to prevent it from rolling into the hole. When the hole was deep enough, the timber props were removed and the rock dropped into the hole below the street level. Then they covered it with dirt and carted the excess dirt away.

It's an early example of what creative thinking can do to solve a problem. The unsuccessful bidders only thought about moving the rock from one place to another on the city's surface. The peasant looked at the problem from another angle. He considered

another dimension—up and down. He couldn't life it up, so he put it underground !

Managers at the Cleveland Museum used a similar kind of creative thinking to ensure the success of a dazzling exhibit of ancient Egyptian treasures. Taking a different marketing approach, museum managers held a free private showing for the city's taxi drivers. Some of the museum's snooty, blue-blooded patrons scoffed at the idea and dismissed it as an exercise in foolishness. After all, they said, taxi drivers aren't known for their polish or their culture. But the museum managers persisted. Impress the cab drivers, they reasoned, and the "cabbies" would be more likely to recommend the new exhibit to their customers, who would, in turn, flock to the museum. That's exactly what happened. During the exhibit's run in Cleveland the museum enjoyed shoulder-to-shoulder attendance thanks to talkative cab drivers and creative museum managers !

Explain the study in respect of entrepreneurship.

(b) When the 25-years-old Willis Carrier invented the air conditioner in 1902, he originally did not intend it to make humans more comfortable. Instead, he saw practical application for his device in manufacturing operations that needed to control heat and humidity. Carrier's first customer was a frustrated printer whose presses turned out blurry color images because the heat and humidity in the plant caused the papers dimensions to change, which misaligned the colored inks. Other early adopters included a textile mill in Belmont, North Carolina, that had problems with the heat generated by the weaving process that made its cotton yarns fuzzy and hard to weave and a candy maker whose chocolate melted in the summer.

In 1922, the Carrier Engineering Company, which Carrier and six friends formed in 1915 with \$32,600 they scraped together, developed the centrifugal chiller, the first practical method of air conditioning large spaces. It wasn't until 1924 that Carrier began to market the centrifugal chiller for applications other than manufacturing. The company's first customer of air conditioning for human comfort was the J.L. Hudson Department Store in Detroit, Michigan. The store was famous for its bargain sales in the basement of its building and for the many shoppers who fainted as the heat from the throng of customers overwhelmed the crude ventilation system. The store's basement sales became even more popular after Carrier's airconditioning system cooled the basement – and soon the rest of the store as well. Air conditioning caught on among the general public after the owner of three Houston movie theaters installed units, enabling patrons to enjoy a respite from the sweltering summer heat. Soon theaters nationwide adopted the idea, often advertising "Air Conditioning" in bigger letters on their marquees than the name of the movie! Government buildings began to install air conditioning, including the House of Representatives in 1928, the Senate in 1929, the White House in 1930, and the U.S. Supreme Court in 1931. It wasn't until after World War II that sales of small units designed for homes took off.

Throughout the 1950s, Carrier air conditioners became smaller and more powerful, opening new markets for cooling train cars, buses, ocean liners, and even cars. Carrier units were used to cool a special travelling display for Gargantua, a large gorilla that attracted huge audiences throughout Europe and the United States. Today, Carrier systems control the climate in the Sistine Chapel, the Library of Congress, and George Washington's

historic Mount Vernon home as well as in millions of homes, factories and businesses.

The company's first foreign sale was to a Japanese silk factory in 1907. Today the company sells its air-conditioning products in more than 171 countries around the globe and generates sales of \$9 billion a year. Like many entrepreneurs throughout history, Willis Carrier could not have predicted the impact that his small company would have on the world when the idea for air conditioning hit him as he stood on a chilly, fog-shrouded platform waiting for a train. Yet, like many entrepreneurs, the world was never the same because of his ideas and his business. Geraud Davis, current president of Carrier Corporation says, "A humble but determined man, he truly changed the way we work and live"

Questions :

- (i) Was launching a business easier in Willis Carrier's day than it is today? Explain.
 - (ii) Explain how Willis Carrier exhibited the entrepreneurial spirit.
 - (iii) Develop a list of other entrepreneurs whose products, services, or business changed the world. Select one that interests you and prepare a short report on him or her.
- (c) When she was in college, Candace Vanice was a french fry fanatic, but she worried about the fat content of fries cooked the traditional way. "I waited and waited for someone to create fat-free french fries, but no one did," recalls Vanice. "So, I got busy in my own kitchen. I explored a great number of approaches that did not

work, but one recipe showed great promise. That recipe was based on her mother's recipe for crispy french toast, a dish Vanice had enjoyed while growing up. After much experimenting with seasonings Vanice created french fries that tasted as good as the ones at fast-food restaurants but with one major advantage. They contained no fat!

In 1994, Vanice applied for and received a patent for her fat-free fries, and she launched a company, Marvel LLC, to market them. She quickly learned the breaking into the food business and getting a new product on grocers' shelves is no easy task. To gain widespread acceptance in supermarkets, a new product needs a food broker to push it. The problem 27-years old Vanice faced was that both food brokers and super-markets are reluctant to carry products that are not supported by big-time marketing and advertising campaigns. Vanice's company, like most fledgling start-ups, did not have the financial resources to launch an extensive advertising program.

Vanice had faith in her product, however, and believed that customers would flock to buy her fat-free fries once they tasted them. She contacted several super-markets in her hometown of Kansas City and started handing out free samples. She also hired a sampling agency to give away free product samples in stores in the surrounding area. As Vanice and the sampling agency handed out fries, they collected customer feedback, asking people to fill out surveys about the fries. According to customers, her fries were an overwhelming hit! The only remaining question was how to raise the visibility of 8th Wonder Fat Free Fries enough to convince food brokers and supermarkets to carry them. That would be a challenge because Marvel LLC had practically no money for advertising.

Question :

- (i) Develop a creative advertising and promotional plan for Marvel LLC. What unique selling proposition should Vanice use?
- (ii) How should Vanice use publicity to draw attention to her 8th Wonder Fat Free Fries?
- (iii) According to one marketing expert, "A product can be copied or imitated, but a brand cannot". What can entrepreneurs such as Candace Vanice do to build brand name recognition when they do not have the advertising budgets large companies have?

(d) **Consolidated Products**

Consolidated Products is a medium-sized manufacturer of consumer products with nonunionized production workers. Ben Samuels was a plant manager for Consolidated Products for 10 years, and he was well liked by the employees. They were grateful for the fitness center he built for employees, and they enjoyed the social activities sponsored by the plant several times a year, including company picnic and holiday parties. He knew most of the workers by name, and he spent part of each day walking around the plant to visit with them and ask about their families or hobbies.

Ben believed that it was important to treat employees properly so they would have a sense of loyalty to the company. He tried to avoid any layoffs when production demand was slack, figuring that the company could not afford to lose skilled workers that are so difficult to replace. The workers knew that if they had a special problem, Ben would try to help them. For example, when someone was injured but

wanted to continue working, Ben found another job in the plant that the person could do despite having a disability. Ben believed that if you treat people right, they will do a good job for you without close supervision or prodding. Ben applied the same principle to his supervisors, and he mostly left them alone to run their departments as they saw fit. He did not set objectives and standards for the plant, and he never asked the supervisors to develop plans for improving productivity and product quality.

Under Ben, the plant had the lowest turnover among the company's five plants, but the second worst record for costs and production levels. When the company was acquired by another firm, Ben was asked to take early retirement, and Phil Jones was brought in to replace him. Phil had a growing reputation as a manager who could get things done, and he quickly began making changes. Costs were cut by trimming a number of activities such as the fitness center at the plant, company picnics and parties, and the human relations training programs for supervisors. Phil believed that training supervisors to be supportive was a waste of time. His motto was: "If employees don't want to do the work, get rid of them and find somebody else who does."

Supervisors were instructed to establish high performance standards for their departments and insist that people achieve them. A computer monitoring system was introduced so that the output of each worker could be checked closely against the standards. Phil told his supervisors to give any worker who had substandard performance one warning, then if performance did not improve within two weeks, to fire the person. Phil believed that workers don't respect a supervisor who is weak and passive. When Phil observed a worker wasting time or making a mistake, he would reprimand the person right on the spot to set an example. Phil also checked closely on the performance of his supervisors. Demanding objectives were set for each department, and weekly meetings were held with each supervisor to review department performance. Finally, Phil insisted that supervisors check with

him first before taking any significant actions that deviated from established plans and policies.

As another cost-cutting move, Phil reduced the frequency of equipment maintenance, which required machines to be idled when they could be productive. Because the machines had a good record of reliable operation, Phil believed that the current maintenance schedule was excessive and was cutting into production. Finally, when business was slow for one of the product lines, Phil laid off workers rather than finding something else for them to do.

By the end of Phil's first year as plant manager, production costs were reduced by 20 percent and production output was up by 10 percent. However, three of his seven supervisors left to take other jobs, and turnover was also high among the machine operators. Some of the turnover was due to workers who were fired, but competent machine operators were also quitting, and it was becoming increasingly difficult to find any replacements for them. Finally, talk of unionizing was increasing among the workers. •

QUESTIONS

1. Describe and compare the managerial behavior of Ben and Phil. To what extent does each manager display specific relations behaviors (supporting, developing, recognizing) and specific task behaviors (clarifying, planning, monitoring)? To what extent does each manager use participative or inspirational leadership?
2. Compare Ben and Phil in terms of their influence on employee attitudes, short-term performance, and long-term plant performance, and explain the reasons for the differences.
3. If you were selected to be the manager of this plant, what would you do to achieve both high employee satisfaction and performance?

(e) Air Force Supply Squadron

Colonel Pete Novak was assigned to command an air force squadron that airlifted supplies to combat units during the Korean War. The squadron had more than 200 men and several cargo planes. When he assumed command, the situation was bleak. They were short of supplies, personnel, and replacements. Organization and coordination were poor, and there was little cooperation and teamwork among different sections. Morale was low due to the unrelenting workload, the constant bickering and disagreements, and the stress of flying into combat zone.

Colonel Novak held a meeting of the squadron to introduce himself and talk about how important their mission was to the success of the war effort. He talked about how the men in the front lines were counting on the squadron to bring them the supplies and ammunition they needed to keep the enemy from overrunning the country. He reminded them that every man had a vital function in the operation of the squadron.

Then Colonel Novak set out to learn more about the men in his unit, beginning with the officers. He held frequent staff meetings with the section heads and some key noncommissioned officers (NCOs) to discuss the methods used to carry out the mission of the squadron. He visited the enlisted men at work and off duty talking to them and showing a personal interest in them. He listened to their complaints, and whenever possible tried to deal with their concerns about the poor living conditions at the base. He flew along with the airplane crews on some of the supply missions. On one occasion when supplies were desperately needed at the front lines and the squadron was shorthanded, he pitched in and worked beside the men all during the night to load the planes.

It was not long before Colonel Novak had learned each person's name, what his job was, and something about his background. As he found out more about the capabilities of

(Continued)

the men, he reorganized the squadron to place people where the best use could be made of their skills and experience. In staff meetings, disagreements were discussed and worked out, and responsibilities were assigned when all concerned were present. Authority was clearly delegated to reduce confusion and duplication of orders. The NCOs were held responsible for the actions of their men and, within limits, their decisions were enforced without question.

Within two months the effects of the changes were evident. The officers and enlisted men learned what was expected of them and began to see themselves as an essential part of a well-run organization. They began to take pride in their ability to accomplish their mission despite the hardships. Morale and teamwork improved. Before long the squadron became one of the most efficient in Korea.

QUESTIONS :

1. What effective leadership behaviors were exhibited by Colonel Novak?
2. What does this case illustrate about effective leadership?
3. Compare the leadership behavior in this case with the leadership behavior in the preceding case.

(f) Restview Hospital

Mary Carter was the accounting manager at Restview Hospital, a large residential health care facility. The facility administrator, Jack Morelli, explained that he wanted to modernize Restview's system of accounts billing. He asked Mary to investigate available software packages that would be compatible with their computer system. Jack explained that

he and the Restview board of directors would like to make a decision about this matter at the board meeting next month.

A week later Jack asked Mary about her progress, and she reported that she had identified two vendors with appropriate software packages. Jack asked why her list of potential vendors did not include Standard Software Systems, the vendor from which they purchased the software currently used to process Restview's payroll. Standard had just recently developed a software package for accounts billing as a new addition to their product line, but few hospitals were using it. The preliminary information gathered by Mary suggested that Standard's software package was less appropriate for Restview than the packages offered by the other vendors. However, Mary knew that the president of Standard Software was a personal friend of Jack, and she agreed to include Standard among the vendors selected for further consideration.

During the next two weeks, sales representatives from each vendor were invited to make a presentation at Restview to demonstrate and explain their product. Mary had planned to invite the board members to these presentations, but Jack said they were too busy to attend. When the presentations were held, Mary and her office staff asked many questions, but Jack looked bored and said very little. Mary also visited some other hospitals that were already using each type of software package to get firsthand opinions about how well they worked and the difficulties experienced in installing them. During the course of her investigation, she learned that Standard's new software package was less flexible and less user-friendly than the others. All three software packages were about the same price, but the software package from Reliable Computer was clearly the best one for Restview's needs. She prepared a short report to Jack detailing the advantages and disadvantages of each product and making her recommendation.

The next day Mary met with Jack to give him the written report and summarize her findings in person. She explained the reasons for her recommendation to purchase the software package from Reliable Computers, and she reviewed the evidence supporting it. Mary also offered to present her findings to the board of directors at their next meeting, but Jack said he could handle it himself. The board meeting was held the following week, and afterward Jack informed Mary that they decided to go with the software package from Standard. He explained that the board wanted to reward Standard for excellent customer service last year when installing their payroll software at Restview. Two years later, after thousands of dollars of unnecessary expense, the accounts billing Software was still not operating smoothly for Restview.

QUESTIONS :

1. How would you explain the board's decision to purchase the software package from Standard ?
2. How much power relative to this decision did Mary, Jack, and the president of Standard Software possess, and what type of power was it?
3. What could Mary have done to gain more influence over the decision?

(g) Sporting Goods Store

Bill Thompson is the new manager of a retail sporting goods store in Vermont that is part of a national chain. Bill, who is 25 years old, has been working for the company for four years. Before his promotion he was the assistant manager for two years at a company store in Delaware. Last week he was briefly introduced to the employees by his boss, the regional manager.

The profit performance of this store is below average for its location and Bill is looking forward to the challenge of improving profits. When he was an assistant manager, he was given mostly minor administrative duties and paperwork, so this assignment will be his first opportunity to show he can be an effective manager. The base salaries of the 20 employees who work in Bill's store are set by the company, but appraisal ratings by the store manager influence the size of an employee's annual merit raise. These recommendations must be justified to the regional manager, especially if they are not consistent with individual and department sales. Bill can suspend or fire employees with the approval of his boss, but in practice it is difficult to do so unless the recommendation is supported by a strong case.

The store layout and most prices are set by the headquarters office. However, store performance can be affected to a limited extent by the store manager. One way is to keep the cost of employees low by making sure they are working efficiently and not taking excessive sick days. Another way is to ensure that employees are providing a high level of customer service so that customers will return to make other purchases rather than going to a different store next time. Customer service depends on knowing the products well, being polite, providing prompt service, and making sure that inventories of popular goods are maintained so that customers can find what they want. Pay is low for this type of retail selling job, turnover is high, and it takes a few months for a new employee to learn the merchandise well enough to be helpful to customers. Thus, it is also desirable to keep competent employees satisfied enough to stay with the company.

Although it is only his first week on the job, Bill believes that he has already discovered some of the problems at this store. Among the various departments in the store, the ski department has the highest potential profits during the winter, because skiing and snowboarding are popular winter sports

in Vermont. At the current time the department's sales are about average for company stores in the Northeast region, with potential for considerable improvement. On several occasions Bill noticed a line of customers waiting to be served in the ski department, and he overheard some of them grumbling about how long it takes to get served. One customer said he was leaving to go to another store that didn't make him "wait all day to have the privilege of spending hundreds of dollars on ski equipment." Bill observed that Sally Jorgenson, the department manager, spends a lot of time socializing with her salespeople and with customers, including friends who drop in to visit and talk about ski conditions, resorts, fashions, equipment, racing, and so forth. Bill, who doesn't ski, cannot understand what they find so interesting to talk about. He wonders why anybody in their right mind would want to spend a small fortune and risk permanent injury to hurtle down a mountain in blizzard conditions, and then stand in long lines and ride up a freezing chairlift just to do it all over again!

QUESTIONS :

1. How much of each type of power does Bill have at this time?
2. What influence tactics could be used in this situation to influence Sally? Explain what you would actually say to Sally in the process of using each tactic.
3. What should Bill do to improve store performance?

(h) **Astro Airlines**

Arthur Burton established Astro Airlines in 1980, two years after the airlines were deregulated. Burton's vision for the new airline has two key elements. First, the airline would provide low-cost, no-frills service to people who formerly could not afford to travel by air. Second, the airline would have a novel type of organization that provided a better way for people to work together, thereby unleashing their creativity and improving productivity. Burton was a dynamic, emotionally stirring speaker with a kind of evangelical fervor, and he took advantage of every opportunity to teach and affirm his vision. He was regarded by many employees as an inspirational leader who made you believe that you could do anything. The climate at Astro Airlines in the initial years was one of enthusiasm, excitement, and optimism.

Instead of the typical bureaucratic organization, the new company had only three levels of management and few support staff. The emphasis was on equality, informality, participative leadership, and self-management.

Employees were organized into teams with shared responsibility for determining how to do their work. The teams elected members to represent them in advisory and coordinating councils that met with top management, thereby enabling them to participate in making important decisions. Managers were expected to provide direction but not to dictate methods or police efforts. Employees were expected to perform multiple jobs and to learn new skills. Even the managers were expected to spend some time doing regular line jobs to keep informed about problems and customer needs. The status perks found in most large organizations were eliminated. For example, executives answered their own telephones and typed their own letters. New employees were carefully screened, because Burton sought to hire young, enthusiastic employees

who were willing to learn new jobs and who could function as part of a cooperative team. All permanent employees were required to share in the ownership of the company, and they could purchase shares of stock at a reduced price.

Burton believed that a strategy of discount fares and convenient schedules with frequent flights would attract new passengers who would normally travel by car, train, or bus, or who would otherwise not travel. By keeping operating costs low, Astro Airlines was able to offer fares that were much lower than those of competitors. The salaries of managers and employees were lower than normal for the airline industry, although employees also received generous fringe benefits, profit sharing, and stock dividends. Costs were also reduced by purchasing surplus aircraft at bargain rates, by reconfiguring aircraft to carry more passengers (e.g., converting first class into coach seats), and by innovative scheduling that allowed the planes to fly more hours each day. Customers were charged for some frills such as meals and baggage handling that other airlines included in the price of the ticket. To reduce space normally needed for ticket counters at terminals, the ticketing for flights was done either in advance by travel agents or on the plane itself with innovative ticketing machines.

The new company was an immediate success, and passenger volume expanded rapidly. In less than three years the company grew from a few hundred employees with three planes to more than 3,000 employees with 22 planes servicing 20 cities. This success occurred despite dismal conditions that caused widespread operating losses in the airline industry, including a severe economic recession, a crippling national strike of air traffic controllers, and brutal price wars. The flexibility of the company and the commitment and creativity of its employees aided its early growth and facilitated rapid adaptation to crises such as the strike of air traffic controllers.

QUESTIONS :

1. Describe Burton's leadership behavior.
2. Was Burton a charismatic leader in the company at this time? Explain your answer.

(i) Columbia Corporation

Columbia Corp. is a young, rapidly growing company that manufactures computer accessories and specialized components for networked computer workstations. It has some unique products and a strong reputation for quality. However, the market is very competitive, and continued success requires innovation and high quality products. The company currently employs 500 people, a number that has doubled in the past three years. Sales have nearly tripled in the same period, and a recent contract with a large computer company will increase sales even more. However, along with this success the company is also experiencing some problems. Quality rejects have begun to increase, and in recent months the company failed repeatedly to meet delivery schedules.

The top executives include Matt Walsh, CEO and founder of the company, and the vice presidents of production, engineering, sales, and accounting. Walsh is a forceful manager who tightly controls important decisions in the company. The other executives are required to get his approval before making any significant changes in operations. Walsh's style has been to deal, with each VP separately, rather than meeting as a group to address problems. Relationships between departments have been deteriorating for the past two years. Distrust, competition, and political maneuvering have increased, and Walsh intervenes frequently to resolve conflicts between executives. The distrust and hostility has spilled over

to relationships among lowerlevel employees of the departments.

The production VP believes that the rash of quality problems is the result of frequent changes in product design by the engineering department. The production supervisors have little warning of these changes and insufficient time to determine how to make necessary adjustments in production methods. As for the delivery problems, the production VP believes that the sales department makes unrealistic promises to win new customers. Production capacity has not increased fast enough to meet the growing volume of orders, and additional delays are caused by product modifications designed for customers by engineering. The sales VP blames the late deliveries on manufacturing delays. She believes the production people spend so much time trying to correct quality problems that they can't get the product out the door. The sales VP and the engineering VP both believe the production VP is set in his ways and unwilling to adapt to the special needs of important customers.

The sales VP is upset with the accounting VP for tightening customer credit requirements without prior notice. She only discovered the new policy when a key customer complained after credit was denied on a large order. The sales VP believes the new policy will reduce sales, and the reduction will be blamed on her. She complained to Walsh, who apparently approved the decision without understanding the implications. The accounting VP also upset the production VP by abruptly canceling all 'overtime for production employees for the remainder of this month. This action appears unwarranted, and it put production even farther behind schedule. The production VP has asked Walsh to reverse this decision.

Concerned about the growing problems, Walsh asked a management consultant for advice on what to do. The consultant told Walsh that he needs an effective top management team that will work together smoothly to guide

the company through this period of rapid, turbulent growth. The executive team needs to become more adept at understanding and resolving key problems such as insufficient production capacity and declining quality. Walsh asked the consultant for advice on how to create an effective top management team that would take responsibility for shaping the future direction of the company. This change would be consistent with his desire to become less involved in the day-to-day management of the company so that he can spend more time in outside pursuits. The company has made him a millionaire, and he wants to begin enjoying some of the benefits from his success as an entrepreneur. He finds dealing with the day-to-day problems of managing an established company much less fulfilling than it was to create a new company.

SOURCE: Copyright © 1997 by Gary Yukl.

QUESTIONS

1. What issues must be resolved to create an effective executive team?
2. What types of changes should be considered?
3. To what extent is Matt Walsh part of the problem?
4. If Walsh decided to retire, and you were hired from the outside to be the new CEO, explain briefly what you would do during your first year on the job.

(j) Turnaround at Nissan

In 1999, Nissan was in a state of serious decline and had lost money in all but one of the previous eight years. Only Renault's willingness to assume part of Nissan's debt saved

the Japanese company from going bankrupt. As part of the deal, the French auto maker appointed Carlos Ghosn to become Nissan's chief operating officer. However, there was widespread skepticism that the alliance between Renault and Nissan could succeed, or that someone who was not Japanese could provide effective leadership at Nissan.

During the three months prior to assuming the position of COO at Nissan, Ghosn met with hundreds of people, including employees, union officials, suppliers, and customers, to learn more about the company and its strengths and weaknesses. From these meetings and earlier experiences with turnaround assignments, Ghosn understood that major changes would not be successful if they were dictated by him and the experts he brought with him from Renault. Soon after assuming his new position at Nissan in June 1999, Ghosn created nine cross-functional teams and gave them responsibility for determining what needed to be done to revive the company. Such teams had never been used before at Nissan, and it was unusual in a Japanese company to involve a broad cross-section of managers in determining major changes.

The cross functional teams examined different aspects of company operations to identify problems and recommend solutions to Ghosn and the executive committee. Several interrelated problems were identified, and they were mostly consistent with Ghosn's initial impressions. The poor financial performance at Nissan was a joint result of declining sales and excessive costs, and weak management was the primary reason for the failure to resolve these problems. Management lacked a coherent strategy, a strong profit orientation, and a clear focus on customers. There was little cooperation across functions, and there was no urgency about the need for major change.

One reason for excessive costs at Nissan was that only half of the available capacity in the company's factories was being used; production capacity was sufficient to build almost

a million more cars a year than the company could sell. To reduce costs, Ghosn decided to close five factories in Japan and eliminate more than 21,000 jobs, which was 14 percent of Nissan's global workforce. To simplify production operations at the remaining factories and make them more efficient, Ghosn planned to reduce the number of car platforms by half and the number of powertrain combinations by a third. Plant closings can undermine relations with employees, and Ghosn took steps to ensure that employees knew why they were necessary and who would be affected. In general, he understood that most employees prefer to learn what would happen to them and prepare for it, rather than remaining in a state of uncertainty and anxiety. Ghosn attempted to minimize adverse effects on employees by selling subsidiaries and using natural attrition, early retirements, and opportunities for part-time work at other company facilities.

Purchasing costs represent 60 percent of the operating costs for an automaker, and Nissan was paying much more than necessary for the parts and supplies used to build its cars. After comparing expenses at Nissan and Renault, Ghosn discovered that Nissan's purchasing costs were 25 percent higher. One reason was the practice of purchasing small orders from many suppliers instead of larger orders from a smaller number of global sources. It would be necessary to reduce the number of suppliers, even though this action was unprecedented in a country where supplier relationships were considered sacrosanct. Higher purchasing costs were also a result of overly exacting specifications imposed on suppliers by Nissan engineers. The engineers who worked with the cross-functional team on purchasing initially defended their specifications, but when they finally realized that they were wrong, the team was able to achieve greater savings than expected. Excessive purchasing costs are not the type of problem that can be solved quickly, but after three years of persistent effort it was possible to achieve Ghosn's goal of a 20 percent reduction.

Years of declining sales at Nissan were caused by a lack of customer appeal for most of the company's cars. When Ghosn made a detailed analysis of sales data he discovered that only 4 of the 43 different Nissan models had sufficient sales to be profitable. Final decisions about the design of new models were made by the head of engineering. Designers were taking orders from engineers who focused completely on performance, and there was little effort to determine what types of cars customers really wanted. To increase the overall appeal of Nissan vehicles, Ghosn the innovative designer Shiro Nakara, who became another key leader in the turnaround effort. The designers would now have more authority over design decisions, and Ghosn encouraged them to be innovative rather than merely copying competitors. The first time in more than a decade, Nissan began coming up with cars that excited customers both in Japan and abroad. Ghosn planned to introduce 12 new models over a three year period, but the time necessary to get a new model into production meant it few would be available until 2002.

Another reason for declining sales was Nissan's weak distribution network. In Japan strong brand loyalty is reinforced by efforts to maintain close relationships with customers, and it is essential for the dealerships to be managed by people who can build customer loyalty and convert it into repeat sales. In 1999, many Nissan dealerships in Japan were subsidiaries managed by Nissan executives nearing retirement, and they viewed their role more in social terms than as an entrepreneur responsible for helping the company to increase market share and profits. Ghosn reduced the number of company-owned dealerships (10 percent were closed or sold), and he took steps to improve management of the remaining dealerships.

Saving Nissan would also require major changes in human resource practices, such as guaranteed lifetime employment and pay and promotion based on seniority. Transforming these strongly embedded aspects of the company culture without engendering resentment and demoralizing employees was perhaps the most difficult challenge. The changes would

primarily affect nonunionized employees at Nissan, including the managers. A merit pay plan was established, and instead of being rewarded for seniority, employees were now expected to earn their promotions and salary increases through effective performance. Areas of accountability were sharply defined so that performance could be measured in relation to specific goals. New bonuses provided employees an opportunity to earn up to a third of their annual salary for effective performance, and hundreds of upperlevel managers could also earn stock options. These and other changes in human resource practices would make it possible for Ghosn to gradually replace weak middle and upper level managers with more competent successors.

In October 1999, Ghosn announced the plan for revitalizing Nissan. He had been careful to avoid any earlier leaks about individual changes that would be criticized without understanding why they were necessary and how they fit into the overall plan. The announcement included a pledge that Ghosn and the executive committee would resign if Nissan failed to show a profit by the end of 2000. It was an impressive demonstration of his sincerity and commitment, and it made what he was asking of others seem more acceptable. Fortunately, the primary objectives of the change were all achieved on schedule, and by 2001 earnings were at a record high for the company. That year Ghosn was appointed as the chief executive officer at Nissan, and in 2005, he would become the CEO of Renault as well.

QUESTIONS :

1. What was done to improve efficiency, adaptation, and human relations, and how were the potential trade-offs among these performance determinants handled?
2. What effective change management practices were used at Nissan ?

22/11/17

Q. No. XEC - 01 / 721

B. Tech./Odd

2017-18/Reg

2017-18

ENGINEERING MECHANICS

XEC - 01

Full Marks : 50

Time : Three Hours

The figures in the margin indicate full marks.

Group - A

Answer any one questions.

1. The square steel plate has a mass of 1800 kg with mass center at its center G. Calculate the tension in each of the three cables with which the plate is lifted while remaining horizontal. 10

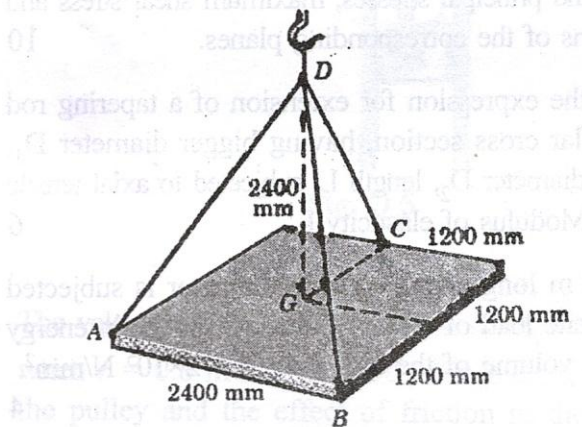


Fig. Q 1

P.T.O.

(2)

2. (a) Determine the relation between the tight side and slack side tensions T_1 and T_2 for a flat belt passing over a fixed cylindrical drum when the belt is just about to slide. Use suitable standard notations as required. 5
- (b) Determine the volume and curved surface area of a hemisphere using the theorems of Pappus. Use standard notations. 5

Group - B

Answer any *one* questions.

3. A standard plane stress element of a body is subjected to a compressive stress of 300 N/mm^2 in x-x direction and a tensile stress of 200 N/mm^2 in the y-y direction. The element is subjected to a shear stress of 100 N/mm^2 such that when it is associated with the compressive stress, it tends to rotate the element in an anti-clockwise direction. Find graphically the normal and shear stresses on a plane whose normal is inclined at an angle of 30° with the x-x axis. Also find principal stresses, maximum shear stress and the directions of the corresponding planes. 10
4. (a) Derive the expression for extension of a tapering rod of circular cross section, having bigger diameter D_1 , smaller diameter D_2 , length L , subjected to axial tensile load P . Modulus of elasticity E . 6
- (b) A bar 2 m long and 25 mm in diameter is subjected to a tensile load of 60 kN. Calculate the strain energy per unit volume of the bar. Take $E = 2 \times 10^5 \text{ N/mm}^2$. 4

(3)

Group - C

Answer any *three* questions.

5. Slider block A moves to the left with a constant velocity of 6 m/s. Determine :
- (a) the velocity of block B ,
- (b) the velocity of portion D of the cable,
- (c) the relative velocity of portion C of the cable with respect to portion D . 10

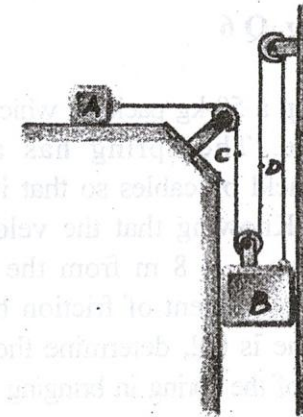


Fig. Q 5

6. The velocity of block A is 2 m/s to the right at the instant when $r = 0.8 \text{ m}$ and $\theta = 30^\circ$. Neglecting the mass of the pulley and the effect of friction in the pulley and

(4)

between block A and the horizontal surface, determine, at this instant,

- the tension in the cable,
 - the acceleration of block A ,
 - the acceleration of block B .
- 10

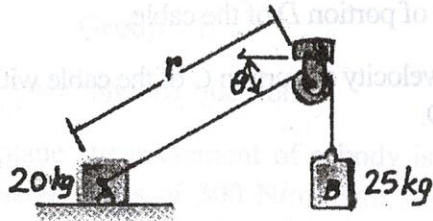


Fig. Q 6

7. A spring is used to stop a 50-kg package which is moving down a 20° incline. The spring has a constant $k = 30 \text{ kN/m}$ and is held by cables so that it is initially compressed 50 mm. Knowing that the velocity of the package is 2 m/s when it is 8 m from the spring and assuming the kinetic coefficient of friction between the package and the incline is 0.2 , determine the maximum additional deformation of the spring in bringing the package to rest.
- 10

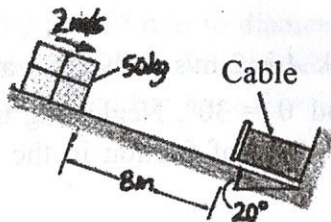


Fig. Q 7

(5)

- 8 A ball is thrown so that the motion is defined by the equations $x = 5t$ and $y = 2 + 6t - 4.9t^2$, where x and y are expressed in meters and t is expressed in seconds.

Determine :

- the velocity and its direction at $t = 1 \text{ s}$,
 - the horizontal distance the ball travels before hitting the ground.
- 10