

**Khulna University of Engineering & Technology**  
**Department of Industrial Engineering and Management**

B.Sc. Engineering 2<sup>nd</sup> Year 2<sup>nd</sup> Term Examination, 2017

**IPE 2207**

Probability and Statistical Analysis

Full Marks: 210

Time: 3 hrs

- N.B:** i) Answer any *THREE* questions from each section in separate scripts.  
 ii) Figures in the right margin indicate full marks.  
 iii) Assume reasonable data if missing any.

**SECTION-A**

1. (a) State the Bayes' rule. 05
- (b) If the independent probabilities that three people A, B, and C will be alive in 30 years are 0.40, 0.30, and 0.20 respectively, calculate the probability that in 30 years 10  
 i) all will be alive;  
 ii) none will be alive;  
 iii) Only one will be alive.
- (c) A bag contains 2 red, 3 green and 2 blue balls. Two balls are drawn at random. What is the probability that none of the balls drawn is blue? 08
- (d) A large industrial firm uses three local motels to provide overnight accommodations for its clients. From past experience it is known that 20% of the clients are assigned rooms at the Ramada Inn, 50% at the Sheraton, and 30% at the Lakeview Motor Lodge. If the plumbing is faulty in 5% of the rooms at the Ramada Inn, in 4% of the rooms at the Sheraton, and in 8% of the rooms at the Lakeview Motor Lodge, what is the probability that 12  
 i) A client will be assigned a room with faulty plumbing?  
 ii) A person with a room having faulty plumbing was assigned accommodations at the Lakeview Moto Lodge?
2. (a) Define Random variable with proper example. 05
- (b) From a box containing 4 black balls and 2 green balls, 3 balls are drawn in succession, each ball being replaced in the box before the next draw is made. Find the probability distribution for the number of green balls. 10
- (c) An important factor in solid missile fuel is the particle size distribution. Significant problems occur if the particle sizes are too large. From production data in the past, it has been determined that the particle size (in micrometers) distribution is characterized by 12  

$$f(x) = \begin{cases} 3x^{-4}, & x > 1 \\ 0, & \text{elsewhere} \end{cases}$$
 i) verify that this is a valid density function;  
 ii) What is the probability that a random particle from the manufactured fuel exceeds 4 micrometers?
- (d) The number of persons X, in a Singapore family chosen at random, has the following probability distribution: 08
- |      |      |      |      |      |      |      |      |      |
|------|------|------|------|------|------|------|------|------|
| X    | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    |
| f(x) | 0.34 | 0.44 | 0.11 | 0.06 | 0.02 | 0.01 | 0.01 | 0.01 |
- Find the average family size E(X).
3. (a) Write down the properties of poisson process. 05
- (b) According to the study published by a group of university of Massachusetts sociologist, approximately 60% of the valium users in the state of Massachusetts first took valium for psychological problems. Find the probability that among the next 8 users from this state who are interviewed- 15  
 i) exactly 3 began taking valium for psychological problems;  
 ii) at least 5 began taking valium for problems that were not psychological;  
 iii) No more than 2 began taking valium for psychological problems.

3. (c) Service calls come to a maintenance center according to a poisson process, and on average, 2.7 calls are received per minute. Find the probability that
- no more than 4 calls come in any minute;
  - newer than 2 calls come in any minute;
  - More than 10 calls come in a 5-minute period.
4. (a) What is meant by moment generating function (MGF)? 05
- (b) Define reliability of system. 05
- (c) The time required to repair a machine is an exponential random variable with rate  $\lambda=0.5$  10  
downs/hour.
- What is the probability that a repair time exceeds 2 hours?
  - What is the probability that the repair time will take at least 4 hours given that the repair man has been working on the machine for 3 hours?
- (d) An electrical system consists of five components as shown in figure 4(d) with probability. 15  
All the components work independently.
- Find the probability that the entire system works.
  - Given that the system works, what is the probability that the component A is not working.

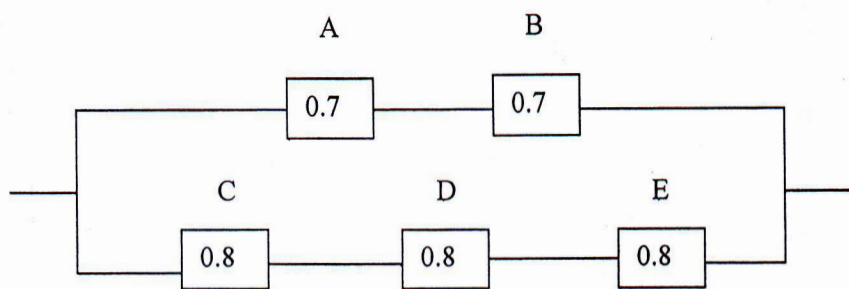


Figure 4(d)

**SECTION-B**

5. (a) What is normal distribution? In an industrial process the diameter of a ball bearing is an important component part. The buyer sets specifications on the diameter to be  $3.0 \pm 0.01$  cm. The implication is that no part falling outside these specifications will be accepted. It is known that in the process the diameter of a ball bearing has a normal distribution with mean  $\mu = 3.0$  and standard deviation  $\sigma = 0.005$ . On the average, how many manufactured ball bearings will be scrapped. 12
- (b) A research firm conducted a survey to determine the mean amount steady smokers spend on cigarettes during a week. The found distribution of amounts spent per week followed the normal distribution with standard deviation of \$5. A sample of 49 steady smokers revealed that  $\bar{x} = \$20$ . 12
- What is the point estimate of the population mean? Explain what it indicates.
  - Using the 95 percent level of confidence, determine the confidence interval for  $\mu$ . Explain what it indicates.
- (c) Merrill Lynch Securities and Health Care Retirement Inc., are two large employers in down-town Toledo, Ohio. They are considering jointly offering child care for their employees. As a part of the feasibility study, they wish to estimate the mean weekly child-care cost of their employees. A sample of 10 employees who use child care reveals the following amounts spent last week. 11
- |       |      |      |      |       |       |      |      |      |       |
|-------|------|------|------|-------|-------|------|------|------|-------|
| \$107 | \$92 | \$97 | \$95 | \$105 | \$101 | \$91 | \$99 | \$95 | \$104 |
|-------|------|------|------|-------|-------|------|------|------|-------|
- Develop a 90 percent confidence interval for the population mean. Interpret the result.
6. (a) What is estimation? There are 250 families in Scandia, Pennsylvania. A random sample of 40 of these families revealed the mean annual church contribution was \$450 and the standard deviation of this was \$75. Could the population mean be \$445 or \$425? 11
- What is the population mean? What is the best estimate of the population mean?
  - Discuss why the finite-population correction factor should be used.
  - Develop a 90 percent confidence interval for the population mean. What are the endpoints of the confidence interval?

6. (b) Jamestown steel company manufactures and assembles desks and other office equipment at several plants in western new York state. The weekly population of the Model A325 desk at the Fredonia plant follows a normal probability distribution with a mean of 200 and a standard deviation of 16. Recently, because of market expansion, new production methods have been introduced and new employees hired. The vice president of manufacturing would like to investigate whether there has been a change in the weekly production of the Model A325 desk. Is the mean number of desks produced at the Fredonia plant different from 200 at the 0.01 significance level? 13

- (c) The manufacture of the X-15 steel-belted radial truck tire claims that the mean mileage the tire can be driven before the tread wears out is 60,000 miles. The population standard deviation of the mileage is 5,000 miles. Crosset Truck Company bought 48 tires and found that the mean mileage for its truck is 59,500 miles. Is Crosset's experience different from that claimed by the manufacturer at the 0.05 significance level? 11

7. (a) The mean length of a small counterbalance bar is 43 millimeters. The population supervisor is concerned that the adjustments of the machine producing the bars have changed. He asks the Engineering department to investigate. Engineering department selects a random sample of 12 bars and measures each. The results are reported below in millimeters. 12

42	39	42	45	43	40	39	41	40	42	43	42
----	----	----	----	----	----	----	----	----	----	----	----

Is it reasonable to conclude that there has been a change in the mean length of the bars? Use the 0.02 significance level.

- (b) Experience raising New Jersey Red Chickens revealed the mean weight of the chickens at five months is 4.35 pounds. The weight follows the normal distribution. In an effort to increase their weight a special additive is added to the chicken feed. The subsequent weights of a sample of five-month old chickens were (in pounds): 12

4.41	4.37	4.33	4.35	4.30	4.39	4.36	4.38	4.40	4.49
------	------	------	------	------	------	------	------	------	------

At the 0.01 level, has the special additive increased the mean weight of the chicken? Estimate the p-value.

- (c) A group of department store buyers viewed a new line of dresses and gave their opinions of them. The results were: 11

Opinion	Number of buyers	Opinions	Number of buyers
Outstanding	47	Good	39
Excellent	45	Fair	35
Very good	40	Undesirable	34

Because the largest number (47) indicated the new line is outstanding, the head designer thinks that is a mandate to go into mass production of the dresses. The head sweeper (who somehow became involved in this) believes that there is not a clear mandate and claims that the opinions are evenly distributed among the six categories. He further states that the slight differences among the various counts are probably due to chance. Test the null hypothesis that there is no significance difference among the opinions of the buyers. Test at the 0.01 level of risk.

8. (a) Describe interaction effect. 12

- (b) For many years TV executives used the guideline that 30 percent of the audiences were watching each of the traditional big three prime-time networks and 10 percent were watching the cable stations on a weekday night. A random sample of 500 viewers in the Tampast. Petersburg, Florida, area last Monday night showed that 165 homes were tuned into the ABC affiliate, 140 to the CBS affiliate, 125 to the NBC affiliate and the remainders were viewing a cable station. At the 0.05 significance level, can we conclude that the guideline is still reasonable? 15

- (c) Write down the limitations of chi-square distribution. The safety direction of Honda USA took sample at random from company record of minor work related accidents and classified according to the time of the accident took place. 08

Time	No. of accident	Time	No. of accident
8 to 9 A.M.	6	1 to 2 P.M.	7
9 to 10 A.M.	6	2 to 3 P.M.	8
10 to 11 A.M.	20	3 to 4 P.M.	19
11 to 12 P.M.	8	4 to 5 P.M.	6

Using 0.01 level of significance, determine the accidents are evenly distributed throughout the day. Write brief explanation of your conclusion.

**Khulna University of Engineering & Technology**  
**Department of Industrial Engineering and Management**

B.Sc. Engineering 2<sup>nd</sup> Year 2<sup>nd</sup> Term Examination, 2017

**IPE 2229**

Industrial Psychology and Law

Full Marks: 210

Time: 3 hrs

- N.B:** i) Answer any THREE questions from each section in separate scripts.  
ii) Figures in the right margin indicate full marks.  
iii) Assume reasonable data if missing any.

**SECTION-A**

1. (a) Define Industrial Psychology. Describe the scope and importance of industrial psychology for industrial engineers. 13  
(b) What are the research and practice areas for industrial psychologist? 12  
(c) Describe the job descriptive index (JDI). 10
2. (a) What is "Social Loafing"? Describe five stage model of group development briefly. 10  
(b) Define personality. Explain "Trait Theories" and "Humanist Theories" of personality. 12  
(c) Define propaganda. Describe the different techniques in propaganda. 13
3. (a) What are the differences between leadership and management? Explain. 10  
(b) Define motivation. Describe the need theories with example. 13  
(c) Describe different types of leadership style with example. 12
4. (a) Describe different types of prejudice exist in society. 12  
(b) What do you mean by work stress? Describe the impacts of work stress. 11  
(c) What is Grapevine communication? How can it effect mass communication? Discuss with example. 12

**SECTION-B**

5. (a) List down the major objective of Industrial Law. Define "Manufacturing Process" and "Worker" according to the factory act 1965. 10  
(b) Define factory. What are the key responsibilities of a chief inspector? 12  
(c) State the provisions for lighting and artificial humidification in a factory. 13
6. (a) State the provisions of "Weekly Working Hours", "Weekly Holiday and "Interval for Rest or Meal" for worker in an establishment. 13  
(b) Discuss the provisions associated with the "fencing of machinery" in an establishment. 07  
(c) State the provision for register of adult workers and supply of tickets and cards. 10  
(d) Discuss the provision of "Casual Leave" and "Sick Leave" for worker in an establishment. 05
7. (a) Explain the following terms i) Trade Union ii) Industrial Dispute. 10  
(b) Discuss the unfair labour practices on the part of workmen, according the industrial relation ordinance, 1969. 12  
(c) When notice of strike or lock-out should be served? What are the proceedings before conciliation and when the conciliation proceedings deemed to be an end? 13
8. (a) Define labour court and labour appellate tribunal. What are the penalties for unfair labour practices? 12  
(b) Define "Ecosystem" and "Pollution" according to "The Bangladesh Environment Conservation Act, 1995". 06  
(c) Write down the procedures for issuing certificate of environment clearance as described in environmental conservation rules, 1997. 14  
(d) Define the term "Go-Slow" in an establishment. 03

**Khulna University of Engineering & Technology**  
**Department of Industrial Engineering and Management**

B.Sc. Engineering 2<sup>nd</sup> Year 2<sup>nd</sup> Term Examination, 2017

**EEE 2211**

Electronics

Full Marks: 210

Time: 3 hrs

- N.B:** i) Answer any THREE questions from each section in separate scripts.  
 ii) Figures in the right margin indicate full marks.  
 iii) Assume reasonable data if missing any.

**SECTION-A**

- Define p-n junction. Draw and explain the V-I characteristics of p-n junction. What is depletion layer? Why it is so called? 12
  - What is doping? Why it is necessary in semiconductor materials? 05
  - Define ripple factor. Derive the expression for ripple factor of a full wave bridge rectifier. 08
  - A crystal diode having an internal resistance  $r_f = 200\Omega$  is used for half wave rectification. If the applied voltage  $V = 100\sin 100\pi t$  and load resistance  $R_L = 800\Omega$  find i)  $I_m, I_{dc}$ , and  $I_{r.m.s}$  ii) a.c power output iii) d.c output voltage and iv) Rectification efficiency. 10
- Define load line and operating point. Draw the load line for figure 2(a), and also find the value of Q point if  $I_B = 10\mu A$  and  $\beta = 100$ . 13

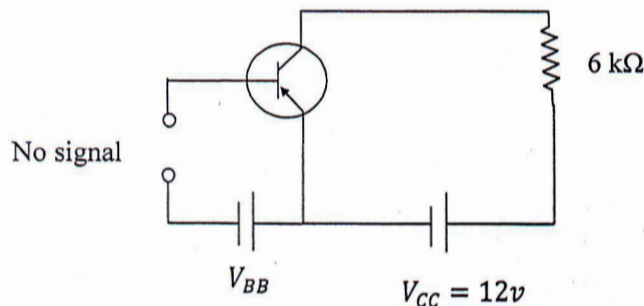


Figure 2(a)

- Derive the following expression for BJT. 12
  - $\beta = \frac{\alpha}{1-\alpha}$
  - $I_C = \beta I_B + I_{CEO}$
- Determine  $I_{BQ}, I_{CQ}$ , and  $V_{CEQ}$  for following circuit of figure 2(c). 10

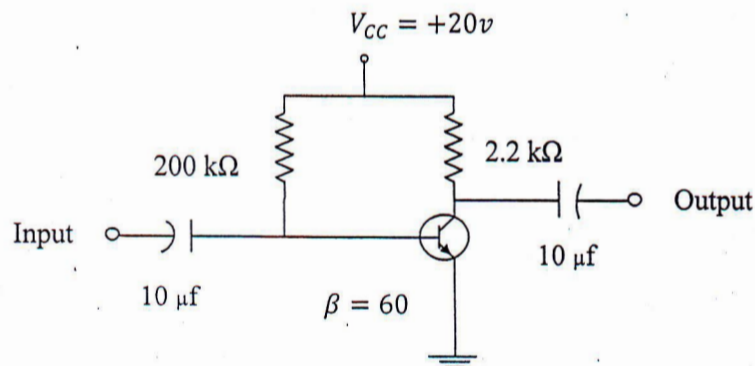


Figure 2(c)

- Explain the V-I characteristics of an SCR. Draw the two transistor model of SCR. 13
  - What is electrical resistance welding? Draw the basic circuit arrangement of ac electrical resistance welding and describe its different parts. 12
  - What is op-amp? How op-amp can be used as i) a differentiator and ii) an integrator. 10

4. (a) Define dielectric heating. Draw the block diagram of a.c electric resistance welding system and briefly explain the fundamental blocks. 10  
 (b) Draw CMOS inverter circuit. Explain the operation of CMOS inverter in brief. 10  
 (c) Mention some applications and advantages of UJT. A UJT has 10V between the bases. If the intrinsic stand off ratio is 0.65, find the value of stand off voltage and also find the value of peak point voltage for  $V_D = 0.7V$ . 10  
 (d) Write short notes on i) LED ii) Photo diode. 05

**SECTION-B**

5. (a) What is binary logic? Express the switching circuit in binary logic notation. 05

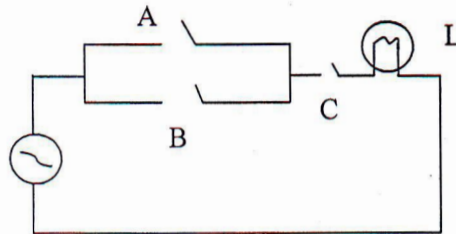


Figure 5(a)

- (b) Write the basic theorems and properties of Boolean algebra and prove them. 12  
 (c) What are minterms and maxterms? Show minterms and maxterms for three binary variables. 08  
 (d) What is switching circuit? Write down the name, graphic symbol, algebraic function and truth table of different logic gates. 10
6. (a) Convert the decimal number 200.5 to base 3, base 4, base 7, base 8 and base 16. 12  
 (b) What are universal gates? Show that all basic gates can be implemented by universal gates. 10  
 (c) Find the Boolean function of a full adder circuit and implement the circuit by using two half adder and an OR gate. 13
7. (a) What do you mean by positive logic and negative logic? Show that a positive logic AND gate is a negative logic OR gate and vice-versa. 10  
 (b) Describe J-K, D and T-flip-flops with neat sketches and characteristic tables. 15  
 (c) Define counter. Design a 3-bit binary counter with T-flip-flops from its excitation tables. 10
8. (a) Define integrated circuit. Classify it and write advantages and disadvantages of it. 08  
 (b) What is microprocessor? Draw the internal architecture of an 8085 up. 10  
 (c) Simplify the following Boolean function in i) Sum of products and ii) Product of sums. 12  

$$F(A, B, C, D) = \sum (0, 1, 2, 5, 8, 9, 10)$$
  
 (d) What are the different types of communication? Define them and write the differences between analog and digital communication. 05

**Khulna University of Engineering & Technology**  
**Department of Industrial Engineering and Management**

B.Sc. Engineering 2<sup>nd</sup> Year 2<sup>nd</sup> Term Examination, 2017

**ME 2213**

Mechanics of Solid

Full Marks: 210

Time: 3 hrs

- N.B:** i) Answer any THREE questions from each section in separate scripts.  
 ii) Figures in the right margin indicate full marks.  
 iii) Assume reasonable data if missing any.

**SECTION-A**

1. (a) A horizontal bar of negligible mass hinged at A in figure 1(a) and assume rigid is supported by a bronze rod 2.0 m long and a steel rod 1.0m long. Using the data in accompanying table, compute the stress in each rod. 10

	Steel	Bronze
Area (mm <sup>2</sup> )	600	300
E (GPa)	200	83
Proportional limit (MPa)	240	14

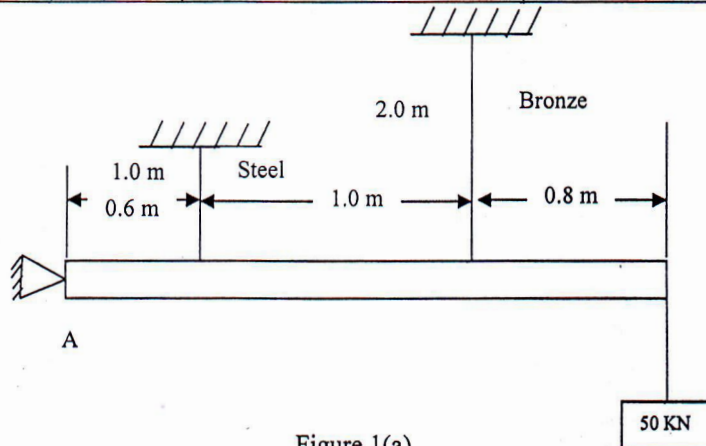


Figure 1(a)

- (b) A rigid bar of negligible weight is supported as shown in figure 1(b). If  $W=80\text{KN}$ , compute the temperature change that will cause the stress in the steel rod to be 55 MPa. Assume the coefficient of linear expansion are  $11.7 \mu\text{m}/(\text{m} \cdot ^\circ\text{C})$  for steel and  $18.9 \mu\text{m}/(\text{m} \cdot ^\circ\text{C})$  for bronze. 12

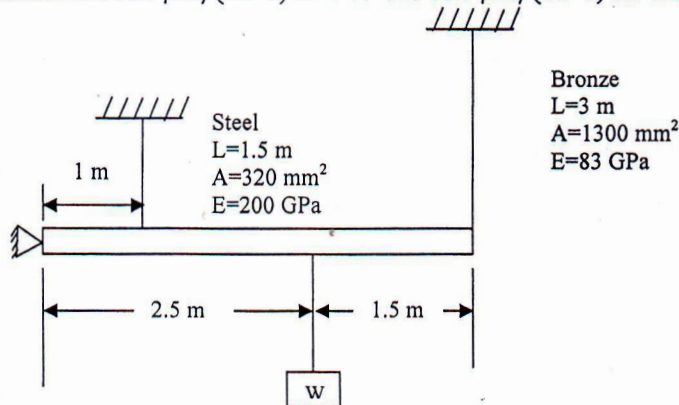


Figure 1(b)

- (c) A rigid horizontal bar of negligible mass is connected to two rods as shown in figure 1(c). If the system is initially stress free. Calculate the temperature change that will cause a tensile stress of 90 MPa in the brass rod. Assume that both rods are subjected to the change in temperature. 13

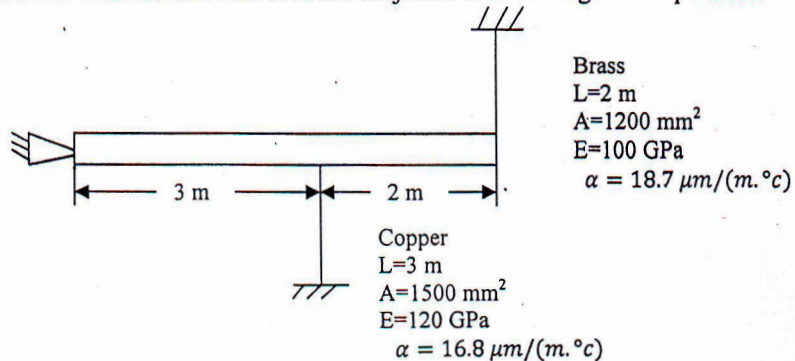


Figure 1(c)

2. (a) The compound shaft shown in figure 2(a) is attached to rigid supports. For the brass segment AB, the maximum shearing stress is limited to 1800 Psi and for the steel segment BC; it is limited to 12 Ksi. Determine the diameter of each segment so that each material will be simultaneously stressed to its permissible limit when torque  $T=12$  Kip.ft is applied. For bronze  $G=6 \times 10^6$  Psi and for steel  $G=12 \times 10^6$  Psi.

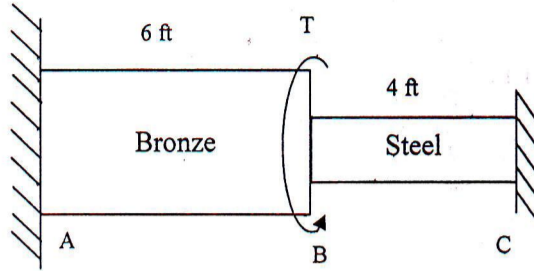


Figure 2(a)

- (b) A torque  $T$  is applied as shown in figure 2(b) to a solid shaft with built in ends. Prove that the resisting torque at the walls are  $T_1 = \frac{Tb}{L}$  and  $T_2 = \frac{Ta}{L}$ . How would this value be changed if the shaft were hollow?

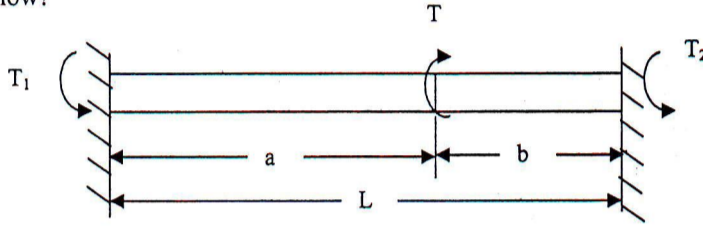


Figure 2(b)

- (c) A rigid bar, hinged at one end, is supported by two identical springs as shown in figure 2(c). Each spring consists of 20 turns of 10 mm wire having a mean diameter of 150 mm. Compute the maximum shearing stress in the springs neglect the mass of the rigid bar.

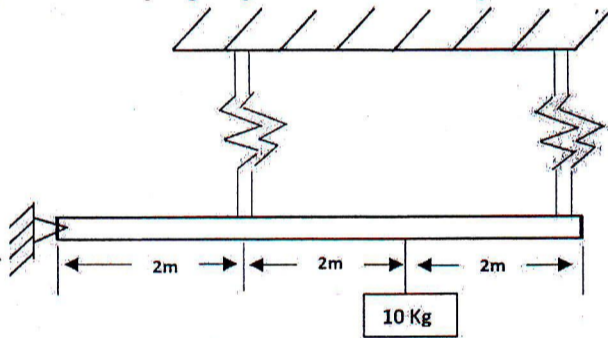


Figure 2(c)

3. (a) Draw moment and load diagrams corresponding to the given shear diagram in figure 3(a) and specify values at all changes of loading positions and at all points of zero shear.

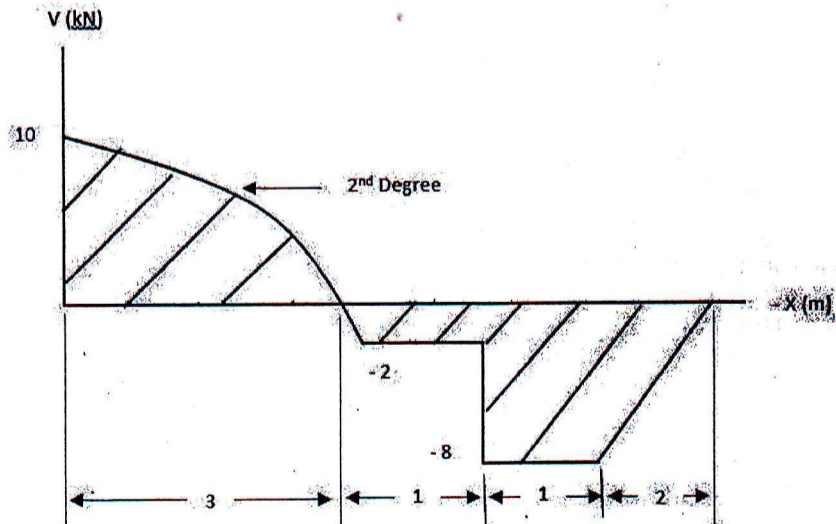


Figure 3(a)

- (b) Draw moment and load diagram corresponding to the given shear diagram in figure 3(b). Specify values at all changes of load positions and at all points of zero shear.



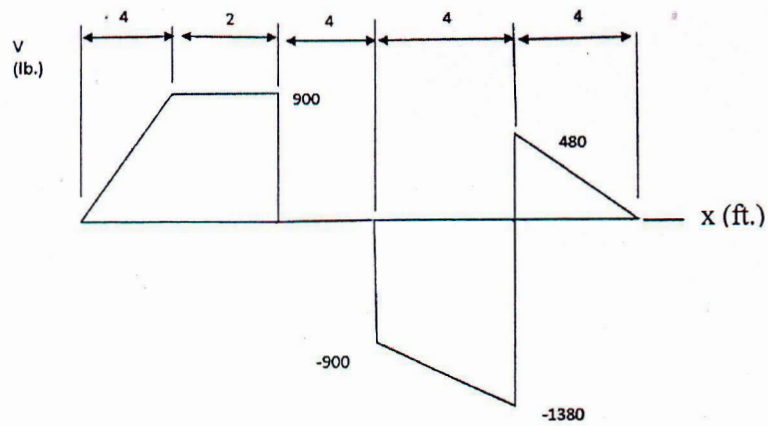


Figure 3(b)

3. (c) Draw shear and moment diagram for the beam specified in figure 3(c). Also give the numerical values at all changes of loading positions and at all points of zero shear. 12

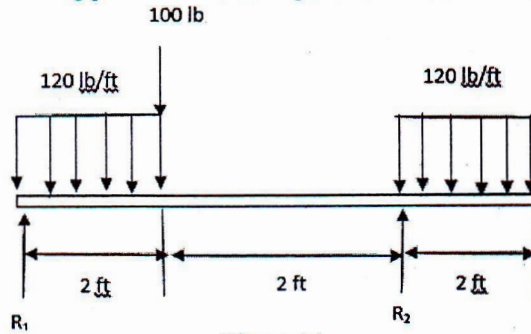


Figure (c)

4. (a) Determine the maximum tensile and compressive bending stresses developed in the beam shown in figure 4(a). 17

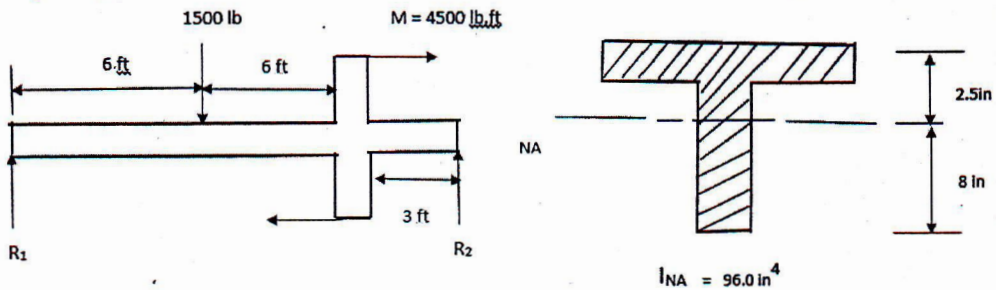


Figure 4(a)

- (b) Using area moment method, for the overhanging beam shown in figure 4(b), compute the moment of area about C of the moment diagram included between the support at A and C 18

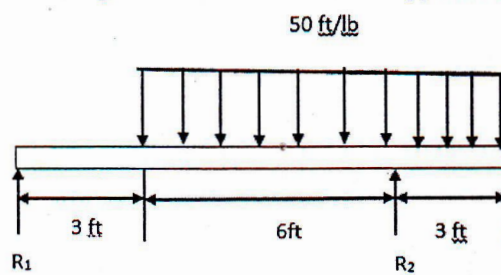


Figure 4(b)

**SECTION-B**

5. (a) Write down the assumption of flexural formula. 05  
 (b) For the overhanging beam shown in figure 5(b), compute the moment of area of the moment diagram between the reactions about the right reaction. 16

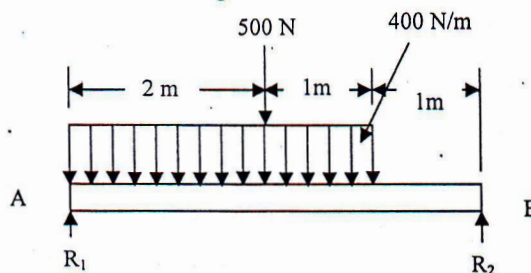


Figure 5(b)

5. (c) Determine the largest load  $P$  that can be supported by the circular steel bracket shown in figure 5(c), if the normal stress on section A-B is limited to 80 MPa. 14

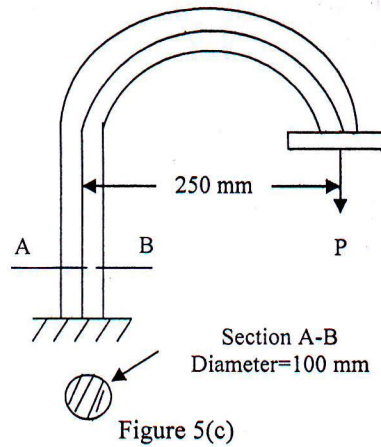


Figure 5(c)

6. (a) Show that maximum and minimum shear stresses occur on planes of zero shearing stress. 16  
 (b) A state of stress is specified in figure 6(b). Determine the normal and shearing stresses on i) the principal planes ii) the planes of minimum in-plane shearing stress and iii) the planes whose normal are at  $+41.8^\circ$  and  $+131.8^\circ$  with the X axis. Show the results of part i) and ii) on complete sketches of differential elements. 19

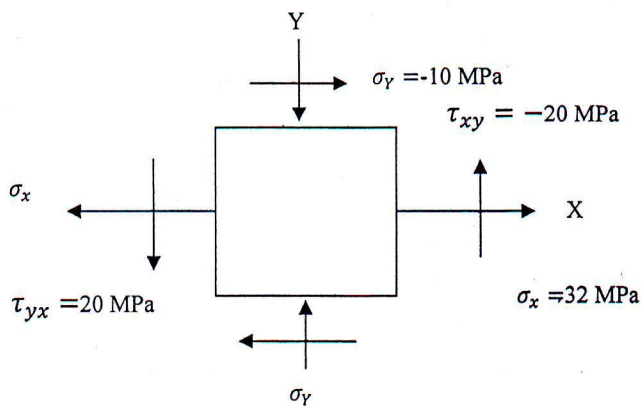


Figure 6(b)

7. (a) Explain critical load. Derive Euler's formula for long column. Write down the limitation of Euler's formula. 15  
 (b) Define slenderness ratio. How slenderness ratio affect the column formula. 05  
 (c) A W 310x52 section is used as a column with hinged ends. Using AISC specifications, determine the maximum load that can be applied, if  $L=14\text{m}$ . Use  $\sigma_{yp} = 250\text{ MPa}$  and  $E = 200\text{ GPa}$ . 15
8. (a) Determine the maximum length of a W250x167 section used as a hinged end column to support a load of 1600 KN. Use AISC specifications with  $\sigma_{yp} = 380\text{ MPa}$  and  $E = 200\text{ GPa}$ . 18  
 (b) A load of 36 Kips acts on the repeating section of the triple-row riveted butt joint shown in figure 8(b). The length of the section is 8 in; diameter of the rivet hole is  $\frac{15}{16}\text{ in}$ ; thickness of main plate is  $\frac{1}{2}\text{ in}$ ; and each cover plate is  $\frac{3}{8}\text{ in}$ . Determine the shearing, bearing and tensile stresses developed in the joint. 17

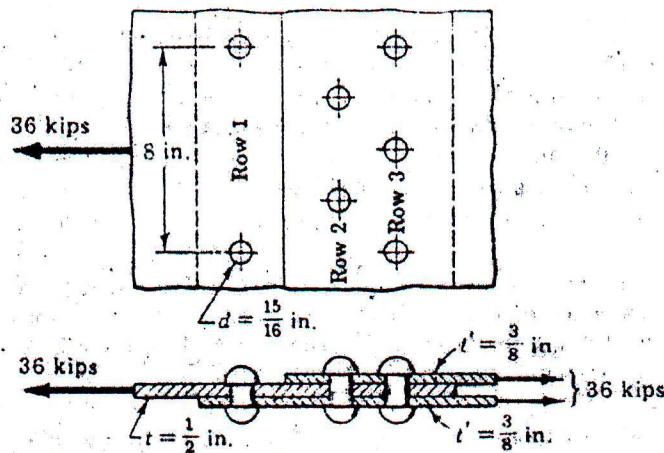


Figure 8(b)

**Khulna University of Engineering & Technology**  
**Department of Industrial Engineering and Management**

B.Sc. Engineering 2<sup>nd</sup> Year 2<sup>nd</sup> Term Examination, 2017

ME 2215

Thermal Engineering and Heat Transfer

Full Marks: 210

Time: 3 hrs

**N.B:** i) Answer any *THREE* questions from each section in separate scripts.  
ii) Figures in the right margin indicate full marks.  
iii) Assume reasonable data if missing any.

**SECTION-A**

1. (a) What is meant by thermodynamic system? State and explain Zeroth law of thermodynamics. Why this law has been named so? 10  
(b) Write down the limitations of 1<sup>st</sup> law of thermodynamics. Explain the perpetual motion machine of 1<sup>st</sup> kind. 10  
(c) What is meant by renewable energy? Explain briefly the different sources of renewable energy available in Bangladesh. 10  
(d) Show that heat and work are path functions. 05
2. (a) Define IC engine. What are the differences between four stroke diesel engine and four stroke petrol engines? 13  
(b) Discuss about the coil ignition system of petrol engine. 12  
(c) Define steady flow with the necessary assumptions. Derive steady flow energy equations (SFEE). 10
3. (a) What is meant by steam boiler? What are the functions of boiler mountings and boiler accessories? 10  
(b) Explain with neat sketch the working of a Cochran boiler. 10  
(c) An oil engine, working on the dual combustion cycle, has a compression ratio 10 and cut-off takes place at 1/10 of the stroke. If the pressure at the beginning of compression is 1 bar and maximum pressure 40 bars, determine the air standard efficiency of the cycle. Take  $\gamma = 1.4$ . 15
4. (a) Write down the functions of following: 08  
i) Fusible plug ii) Economizer iii) Safety plug iv) Air pre-heater  
(b) Draw a line diagram of air conditioning system required in summer season. Explain the working of different components in the circuit. 12  
(c) A gas turbine plant consists of two stage compressor with perfect intercooler and a single stage turbine. If the plant works between the temperature limits of 300 K and 1000 K and 1 bar and 16 bar; find the net power of the plant per kg of air. Take specific heat at constant Pressure as 1 kJ/kgk. 15

**SECTION-B**

5. (a) What are the basic differences between heat transfer and thermodynamics? State Fourier's law of heat conduction. 10  
(b) Discuss about the relation between surface roughness and interface conductance with suitable example. 10  
(c) A 10 cm OD steam pipe maintained at  $T_i=130^\circ\text{C}$  is covered with asbestos insulation  $L=3$  cm thick [ $k=0.1\text{W}/(\text{m}\cdot^\circ\text{C})$ ]. The ambient air temperature is  $T_\infty=30^\circ\text{C}$  and the heat transfer co-efficient for convection at the outer surface of the asbestos insulation is  $h=25\text{W}/(\text{m}^2\cdot^\circ\text{C})$ . By using the thermal resistance concept calculate the rate of heat loss from pipe per 1- m length of pipe. 15

6. (a) Define fin efficiency. Derive one dimensional fin equation for fins with negligible heat loss at the tip. 12
- (b) Derive an expression for LMTD in case of parallel flow heat exchanger. 10
- (c) A 2 cm diameter, stainless steel ball [ $\rho=7865 \text{ kg/m}^3$ ,  $c_p=0.46 \text{ kJ/(kg}\cdot\text{c)}$  and  $k=61 \text{ W/(m}\cdot\text{c)}$ ] is uniformly heated to  $T_i=800^\circ\text{C}$ . It is to be hardened by suddenly dropping it into an oil bath at  $T_\infty=50^\circ\text{C}$ . If the quenching occurs when the ball reaches  $100^\circ\text{C}$  and the heat transfer co-efficient between the oil and the sphere is  $300 \text{ W/(m}^2\cdot\text{c)}$ , how long should the ball be kept in the oil batch? 13
7. (a) What is heat exchanger? Make a comparison between parallel flow and counter flow heat exchangers with necessary sketches. 10
- (b) Define view factor. Derive the reciprocity relation between view factors of two elemental surfaces. 10
- (c) Atmospheric air at  $T_\infty=350\text{K}$  flows with a velocity of  $u_\infty=5 \text{ m/s}$  along a flat plate  $L=1\text{m}$  long. The drag force acting on the plate per 1-m width is  $F=4\times 10^{-2}\text{N}$ . By using the Reynolds-Colburn analogy, estimate the corresponding average heat transfer coefficient  $h_m$ . 15
8. (a) Prove that, the spectral blackbody emissive power is  $\pi$  times the spectral blackbody radiation intensity. 10
- (b) Derive the expression of Reynolds-Colburn analogy. 10
- (c) Two rectangular plates 0.5m by 1m are arranged perpendicular to each other with a common edge, as illustrated in the accompanying figure 8(c). Plate 1 is at  $T_1=1000\text{k}$  and has an emissivity  $\varepsilon_1=0.8$ . Plate 2 is at  $T_2=500\text{k}$  and has an emissivity  $\varepsilon_2=0.6$ . The surroundings ambient can be regarded a black body at  $T_\infty=350\text{K}$ . Sketch the radiation network and calculate the heat transfer rate between the plates. 15

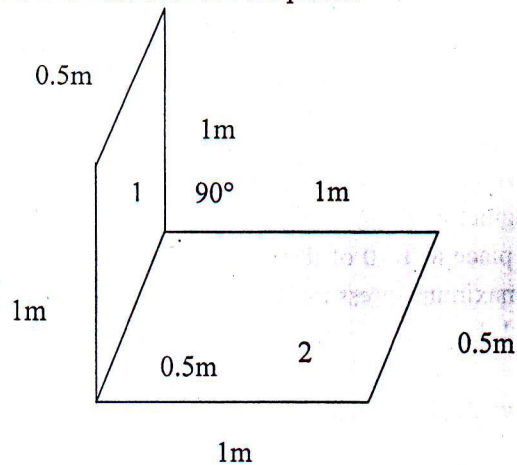


Figure 8(c)