B.E. (Mechanical Engineering) (Semester - VII) Examination,
December- 2018
TOTAL QUALITY MANAGEMENT (Elective - II)
Sub. Code : 67833

Day and Date : Saturday, 01 - 12 - 2018

Time : 02.30 p.m. to 05.30 p.m.

Total Marks : 100

Instructions : 1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Make suitable assumptions wherever necessary and state them clearly.
4) Use of statistical tables and scientific calculator is permitted.

Q1) Solve any two:

a) How cost of Quality is arrived at? What is the normal ratio of individual category costs to cost of Quality? Give examples of prevention expenses. [8]

b) Which symbols are commonly used while preparing flow process chart? Draw a process chart of any process that you know or have seen in an organization. [8]

c) "Satisfied internal customers are creators of culture of commitment". How? [8]

Q2) Solve any Three:

a) What are the fundamentals of product quality planning? Prepare product quality planning chart. [6]

b) How production trial runs help in product and process validation? [6]

c) Explain process capability indices. How these lead to defect prevention? [6]

d) An organization wishes to go for six sigma initiative. Draw the step wise blue print. [6]

Q3) Solve any two:

    a)   What all losses are included in Quality loss function? How these can be addressed through six steps of Taguchi Process?   **[8]**

    b)   How to evaluate parallel, series and combined system reliability?   **[8]**

    c)   A system has three parallel components, X, Y, & Z with reliabilities 0.95, 0.92 & 0.90. How much system reliability will change if component X is out of order?   **[8]**

Q4) Solve any two:

    a)   One key principle of TQM is continual improvement. What steps you suggest to achieve and monitor sustenance of this?   **[8]**

    b)   Elaborate steps suggested by Schonberger to achieve manufacturing excellence.   **[8]**

    c)   Explain with examples role of TEI, JIT & TQC in the context of TQM.   **[8]**

Q5) Solve any three:

    a)   "Getting new customer is difficult than retaining existing customers." Why? Suggest strategies for customer retention.   **[6]**

    b)   Management support and commitment is vital in success of TQM implementation. How the leadership can demonstrate this?   **[6]**

    c)   Differentiate between Quality Circles and CFT on the basis of- participation, focus, objectives and benefits to the organization.   **[6]**

    d)   Which human errors are generally addressed by Poka-Yoke technique?**[6]**

Q6) Slove any two:

    a)   How service quality differs from manufacturing quality? Suggest steps to be taken to enhance service performance with minimum wastes in service.   **[8]**

    b)   ISO/TS: 16949:2009 is automobile sector specific standard. What are its benefits to an organization? Draw road map to achieve ISO/TS.   **[8]**

    c)   Can you describe Baldrige criteria for performance excellence as outlined in Malcom Baldrige Quality Award?   **[8]**

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Seat No.

**B.E. (Mechanical) (Part-IV) (Semester-VIII) (Revised)
Examination, May - 2018
INDUSTRIAL AUTOMATION AND ROBOTICS (Elective-IV)
Sub. Code : 68518**

Day and Date : Wednesday, 16 - 05 - 2018   **Total Marks : 100**
Time : 2.30 p.m. to 5.30 p.m.

Instructions :   1)   All questions are compulsory.
2)   Figures to the right indicate full marks.
3)   Make suitable assumption if necessary and mention them clearly.

Q1) a)   Explain the reasons used to justify the implantation of automation in industry.   **[8]**

b)   Explain the following advanced automation functions: **[8]**

i)   Safety monitoring

ii)   Error detection and recovery

iii)   Maintenance and repair diagnostic

OR

b)   Discuss with an appropriate example the concept of levels of automation. **[8]**

Q2) a)   Analysis of a transfer line without storage buffers.   **[8]**

b)   Storage buffers in automated production systems.   **[8]**

Q3) a)   Explain the four automated assembly system configurations.   **[8]**

OR

a)   Explain following parts in assembly automation.   **[8]**

i)   Hoppers   ii)   Orientation mechanisms.

b)   What are the hardware components of a workstation part delivery system?
[10]

P.T.O.

Q4) a) Explain following terms with respect to robot - Spatial resolution, Load carrying capacity, Compliance, Precision of movement. **[8]**

OR

a) Explain the power transmission systems in robots. **[8]**

b) Explain the common robot configurations and their work volumes. **[8]**

Q5) a) Direct and inverse kinematics solutions in robotics. **[8]**

b) Explain the following gripper mechanisms: **[8]**

   i) Magnetic grippers   ii) Vacuum grippers

Q6) a) Explain a robot program as a path in space. **[8]**

b) Explain the two lead through programming methods in robot. **[10]**

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Seat
No.

B.E. (Mech.) (Part - IV) (Semester - VIII) (Revised)
Examination, May - 2018
ENERGY AND POWER ENGINEERING
Sub. Code: 68509

Day and Date : Monday, 07 - 05 - 2018   **Total Marks : 100**
Time :2.30 p.m. to 5.30 p.m.

Instructions :   1)   All questions are compulsory.

2)   Figures to the right indicate full marks.

3)   Make suitable assumptions if required and state them clearly.

1) a)   Attempt any two: **[10]**

i)   Define declination angle, hour angle and Zenith angle.

ii)   Write procedure to test solar collector as per BIS standard?

iii)   Draw a neat sketch of evacuated tube collector and analyse its use
for different application.

b)   Solve the following: **[8]**

Calculate the angle of incidence of beam radiation with normal to a flat
plate collector, pointing the south location in Kolhapur (16°7'N,74°24'E)
at 10.00 hours solar time on October 29. The collector is tilted at an
angle of 35° with the horizontal. Also calculate day length.

2) Attempt any two: **[16]**

a)   With the help of block diagram explain the operation of grid connected
solar system for residence.

b)   Explain the I-V characteristics of a solar cell and define fill factor. What
is the significance of fill factor?

c)   Explain the principle of operation of Phosphoric Acid Fuel Cell.

P.T.O.

3) Attempt any two: [16]

   a) How the wind mills are classified? Explain with schematic diagram of a VAWT?

   b) Discuss the working principle of open cycle OTEC plant with neat sketch. Write their advantages and disadvantages.

   c) Explain with neat sketch hybrid wind- PV power plant. State their advantages

4) Attempt any two: [16]

   a) Discuss the role of NHPC in power development and present status of hydroelectric power generation in India.

   b) Explain with neat sketch the pumped storage power plant.

   c) Explain the working of power grid for smooth transmission of power from power stations to end user.

5) a) Solve the following: [12]

     A load duration curve of a system is a straight line, the maximum and minimum loads being 100 MW and 20 MW respectively. The load is supplied by base load and peak load plants.

     The cost of both is given as :

     For base load plant: Rs. 200/kW-year + Rs. 0.05/kWh

     For peak load plant: Rs. 50/kW-year + Rs. 0.10/kWh

     For minimum overall cost

     i) Draw the load duration curve.

     ii) Determine the load shared by peak load plant.

     iii) Annual load factors for both stations.

   b) Solve any one: [8]

     i) Explain various tariff methods.

     ii) Describe with neat sketch measurement of smoke and dust in flue gases.

6) Write short notes on (Any two): [14]

   a) Supply chain in power sector.

   b) Human resource in power sector.

   c) Energy audit.

$\mathcal{EEE}$

Seat
No.

B.E. (Mechanical) (Part - IV) (Semester - VIII) (Revised)
Examination, May - 2018
INDUSTRIAL ENGINEERING (Elective - III)
Sub. Code: 68511

Day and Date : Monday, 14 - 05 - 2018   Total Marks : 100
Time :2.30 p.m. to 5.30 p.m.

Instructions :
1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Assume suitable data, if necessary.

Q1) Attempt any four:

a) Describe briefly various functions of industrial engineering.   **[4]**

b) Discuss the applications of industrial engineering in establishing a foundry unit.   **[4]**

c) Define productivity . Describe any two models used in productivity measurement.   **[4]**

d) What are the benefits to various stake holders from productivity?   **[4]**

e) A manufacturing unit is producing 22,000 units of a engine per month by employing 200 workers in 8 hours shift. The company gets an additional order to supply 3000 engines. The management has decided to employ additional workers. What will be the production and productivity levels when the number of additional workers employed is   **[4]**

    i)   20

    ii)   30

P.T.O.

Q2) Attempt any four:

a) How is the work study useful in improving productivity? [4]

b) Differentiate between method study & work measurement. [4]

c) Illustrate the steps of conducting method study. [4]

d) Draw Flow process chart for any one of the welding process. [4]

e) Draw two handed process chart for cutting a glass tube. [4]

Q3) Write short notes on any three:

a) Principles of motion economy related to work place layout. [6]

b) MEMO motion study. [6]

c) SIMO Chart. [6]

d) Design of machinery from ergonomics point of view. [6]

Q4) Attempt any three:

a) Define time study & explain its objectives. [6]

b) Describe various methods used for rating in time study. [6]

c) In the following table, times shown are continuous stopwatch readings in minutes. Initial setting of stopwatch is at 0.00. [6]

Elements	Cycle time (in minutes)				Performance
	1	2	3	4	rating in %
A	1.7	8.55	15.5	22.5	105
B	2.9	9.8	16.75	23.75	90
C	4.5	11.4	18.4	25.35	110
D	6.8	13.8	20.75	27.65	100

Relaxation allowance as 15%. Estimate the standard time of operations and production per 8 hours of shift.

d) State and explain the areas of production where work sampling can be useful. [6]

Q5) Attempt any four:

a) Name and discuss the factors which you need for selection of a plant site for food processing industry. [4]

b) What are the various types of layouts? State the application of each. [4]

c) Explain the tools used in designing the plant layout. [4]

d) Define material handling. State the objective of material handling. [4]

e) Which type of layout do you recommend for a gear manufacturing company? Give reasons. [4]

Q6) Write short notes on any four:

a) Steps involved in value analysis. [4]

b) Applications of value analysis. [4]

c) Procedure of job evaluation. [4]

d) Objectives of merit rating. [4]

e) Ranking method of merit rating. [4]

EEE

B.E. (Mech.) (Part - IV) (Semester - VIII)
Examination, May - 2018
NOISE AND VIBRATION
### Sub. Code: 68510

Day and Date : Friday, 11 - 05 - 2018   Total Marks : 100
Time : 2.30 p.m. to 5.30 p.m.

Instructions :   1)   All questions are compulsory.
                  2)   Assume suitable data wherever necessary.
                  3)   Draw neat sketch wherever necessary.

Q1) a) Enlist different methods of vibration analysis. Using Equilibrium method derive equation of motion for standard spring - mass - system.   **[8]**

   b) Derive the equation of natural frequency for system shown in figure.**[8]**
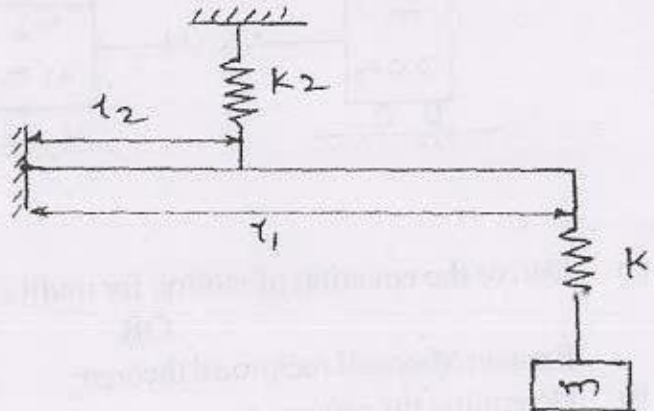
OR

   b) A vibrating system consists of a mass of 50 kg, a spring of stiffness 30 kN/m and a damper. The damping provided is only 20% of the critical value. Determine the damping factor, critical damping coefficient, natural frequency of damped vibrations, logarithmic decrement and the ratio of two consecutive amplitudes.   **[8]**

P.T.O.

Q2) a) Derive the equation of Force Transmissibility. Also explain plot of transmissibility versus frequency ratio. [8]

b) A single cylinder vertical petrol engine of total mass 320 kg is mounted upon a steel chassis and causes static deflection of 2 mm. The reciprocating parts of engine have a mass of 24 kg and move through a vertical stroke of 150 mm with SHM. A dashpot attached to the system offers a resistance of 490 N at a velocity of 0.3 m/s. Determine,

i) The speed of driving shaft at resonance and

ii) The amplitude of steady state vibration when the driving shaft rotates at 480 rpm. [10]

Q3) a) Explain torsionally equivalent shaft. [8]

OR

a) With the help of neat sketch explain Dry Friction Damper. [8]

b) Derive the equation of natural frequency and mode shapes for the system of two masses shown in figure. [8]

$$k = 300 \, N/m$$

$m_1 = 20 \, kg$

$m_2 = 35 \, kg$

$K = 300 \, N/m$
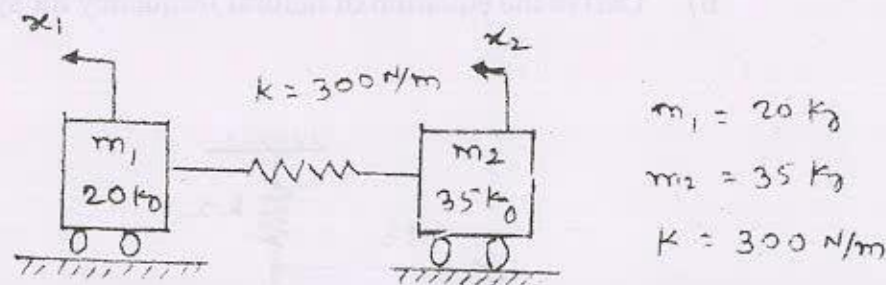
Q4) a) Derive the equation of motion for multi degree spring mass system. [8]

OR

Explain Maxwell reciprocal theorem. [8]

b) Determine the natural frequencies of the system shown in fig. 4b using Matrix Iteration Method. Solve up t o first mode shape. [10]

Q5) a) Explain in brief with neat sketch the instruments Vibrometer, Frahm's. tachometer. State whether used to measure displacement, velocity and/ or frequency. [8]

b) An undamped vibration pick up has a natural frequency of 1 cps. It is used to measure a harmonic vibration of 4cps. If the amplitude indicated by the pickup is 0.125 cm, what is the correct amplitude? [8]

Q6) Attempt any two: [16]

a) Write short note on Octave band analysis and its importance.

b) Discuss Subjective and objective assessment of sound.

c) At a distance of 4 m from a point source, the sound pressure level is 92 dB. Assuming a free progressive spherical wave, and standard atmospheric conditions, calculate the sound pressure level at source.
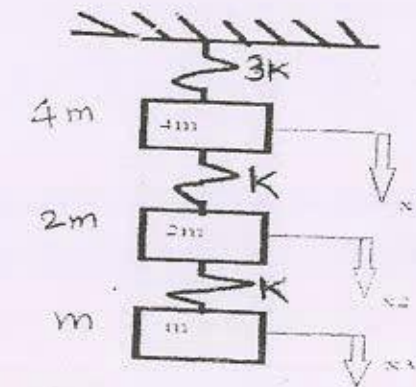

Fig 4b

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Seat
No.

B.E. (Mechanical) (Semester - VII) (Revised) Examination, April - 2018

FINITE ELEMENT ANALYSIS

Sub. Code : 67503

Day and Date : Thursday, 26 - 04 - 2018   **Total Marks : 100**

Time : 02.30 p.m. to 05.30 p.m.

Instructions :
1) Draw neat labeled sketch wherever necessary.
2) Assume suitable data if necessary and state it clearly.
3) Figures to the right indicate full marks.

Q1) a) Write a note on past, present and future of FEA.   [8]

b) If a displacement field is described by   [8]

$$u = 10^{-4}(-x^2 + 2y^2 + 4xy); v = 10^{-4}(2x + 4y - y^2),$$

Determine $\epsilon x, \epsilon y, \gamma_{xy}$ at x = 1; y = 0

OR

b) Explain Rayleigh Ritz method with the help of an example.   [8]

Q2) a) Define shape function. Explain properties of shape function. Also draw the variation of each shape function for a one dimensional linear element.   [8]

OR

Derive the element stiffness matrix and force vector of one dimensional element using potential energy approach.   [8]
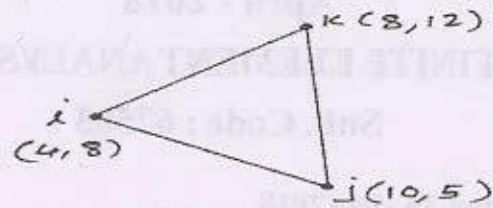
b) For the bar shown below determine nodal displacements and stress in each material   [8]
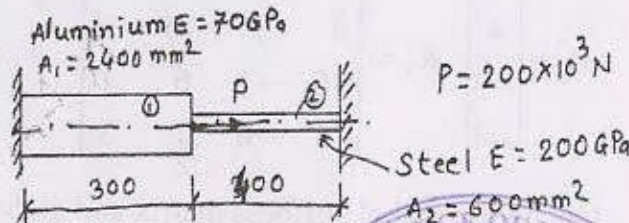

P.T.O.

3) a) Write a short note on isoparametric element. [6]

b) Find the shape function for the triangular element shown below and show that the sum of all shape function is one at any point within the element. [12]

$K(8,12)$

$i (4,8)$

$j(10,5)$

4) a) A long cylinder of 100 mm internal diameter and 130mm external diameter is subjected to hot fluid at 200°C from inside and ambient conditions on outside. Draw the sketch showing actual problem and also model the problem for a sample length of 10mm using axisymmetic element with proper boundary conditions. [6]

b) The stiffness matrices and force vectors of three truss elements shown in figure is as follows:
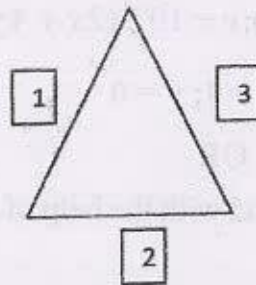
| Element No.	Nodes	
	i	j
1	1	3
2	1	2
3	3	2

Element stiffness matrix and force vector is,

$$K_1 = \begin{vmatrix} 5 & 4 & -5 & -4 \\ 2 & 3 & -2 & -3 \\ -5 & -4 & 5 & 4 \\ -2 & -3 & 2 & 3 \end{vmatrix} \quad F_1 = \begin{vmatrix} 1 \\ -2 \\ -1 \\ 2 \end{vmatrix} \quad K_2 = \begin{vmatrix} 6 & -7 & -6 & 7 \\ -7 & 6 & 7 & -6 \\ -6 & 7 & 6 & -7 \\ 7 & -6 & -7 & 3 \end{vmatrix}$$

$$F_2 = \begin{vmatrix} 3 \\ 4 \\ -3 \\ -4 \end{vmatrix} \quad K_3 = \begin{vmatrix} 6 & 1 & -6 & -1 \\ 1 & 3 & -1 & -6 \\ -6 & -1 & 6 & 1 \\ -1 & -6 & 1 & 3 \end{vmatrix} \quad F_3 = \begin{vmatrix} 2 \\ -3 \\ -2 \\ 3 \end{vmatrix}$$

Obtain the global stiffness matrix and global force vector. [10]

5) a) Derive the relation between B matrix and Jacobian. J matrix for a linear triangular element for a heat transfer problem. [6]

b) A bar of rectangular cross-section having thermal conductivity of 1.5 W/m °C is subjected to boundary conditions as shown in figure. [10]

180°C

$0.3m$ insu-lated $K = 1.5 W/m°c$ $h = 50 W/m^2 °C$ $T_\infty = 25°C$

$0.4 m$ 180°C
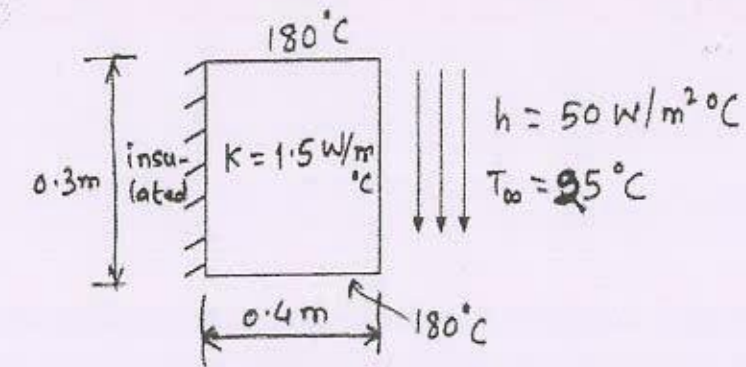
Mesh the domain with three triangular elements and obtain the conductivity matrix of each one.

6) a) Write short notes on any two [10]

i) Free and mapped meshing

ii) Aspect ratio and distortion

iii) Results validation and data interpretation

b) Explain in detail the steps to be carried out in commercial FEA software for a simple structure made up of two truss elements. [8]

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Seat
No.

Total No. of Pages : 3

B.E. (Mechanical) (Part - IV) (Semester - VII)
Examination, April -2018
AUTOMOBILE ENGINEERING (Elective - I)
Sub. Code : 67506

Day and Date :Friday, 27 - 04 - 2018　　　　　**Total Marks : 100**
Time : 2.30 p.m to 5.30 p.m.

Instructions :　1)　All questions are compulsory.
　　　　　　　　2)　Draw neat sketch wherever necessary.
　　　　　　　　3)　Figures to the right indicate full marks.
　　　　　　　　4)　Make suitable assumptions if necessary.
　　　　　　　　5)　Use of non- programmable calculator is allowed.

Q1) a)　Explain in details the automobile body construction, write different materials used for automobile body.　　**[9]**

　　　b)　Explain with neat sketch front engine front wheel drive.　**[8]**

Q2) a)　What are the good requirements of the clutch?　**[8]**

OR

　　　Explain with neat sketch the constructional details of single plate clutch.

　　　b)　What is a need of gear box in automobile? Explain the final drive gears.　**[8]**

Q3) a)　What do you understand from　　**[8]**

　　　　i)　Caster

　　　　ii)　Camber

　　　　iii)　King pin inclination

　　　　iv)　Scrub radius.

P.T.O.

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　　　b)　Which are the different types of springs used in the suspension system? Explain any one of them with neat sketch.　**[9]**

OR

Explain interconnected and self-leveling suspension system.

Q4) a)　Explain with neat sketch Anti - lock braking system used in modern cars. List benefits of ABS over conventional brakes.　**[8]**

　　　b)　Draw a layout sketch of hydraulic braking system used in 4 wheeler vehicle? Explain working and how differential braking is achieved with this system?　**[9]**

OR

List types of power and power assisted brakes used in automobiles? Explain air brake system with neat sketch?

Q5) a)　Draw a neat circut diagram of automobile starting, battery charging and ignition circuit and explain working of all.　**[9]**

　　　b)　Draw a layout sketch of automobile air conditioning system showing all necessary components and explain working?　**[8]**

OR

Explain with neat sketch Electronic Controlled Management (ECM) system used in automobile? List benefits?

Q6) a)　Define and explain how to estimate.　　**[4]**

　　　　i)　Air Resistance.

　　　　ii)　Gradient Resistance.

　　　　iii)　Rolling Resistance.

　　　　iv)　Tractive effort.

OR

a) Explain what is relation between engine speed and road wheel speed? How to select gear box and final drive ratio?

b) A motor vehicle weights 7975.5N and engine develops 14.7 kW at 2500 rpm. At this engine speed road speed of the car on the top gear is 64.37 km/hr. Bottom gear reduction is 3.5:1 and efficiency of transmission is 88% on top and 80% is bottom gear. The diameter of tyre is 0.762 m and the projected frontal area is 1.116 m². The coefficient of air resistance is 0.0314 N-hr²/km²-m² and road resistance is 0.023.W. Estimate. **[12]**

   i) Speed of the car in bottom gear.

   ii) Tractive effort available at wheels in top and bottom gear.

   iii) Gradicut vehicle can climbin bottom gear.

   iv) Tractive effort required to start car in level and to attain speed of 48.28 km/hr in 10 seconds.

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Seat
No.

B.E. (Mechanical) (Part-IV) (Semester - VII) (Revised) (New) Examination, April - 2018
REFRIGERATION AND AIR CONDITIONING
Sub. Code : 67501

Day and Date : Tuesday, 24 - 4 - 2018

Total Marks : 100

Time : 2.30 p.m. to 5.30 p.m.

Instructions :
1) Attempt all questions.
2) Figures to the right indicate full marks.
3) Use same answer book.
4) Neat diagram must be drawn.
5) Use of steam table, refrigerant property table/chart & psychrometric charts are allowed.
6) Make suitable assumptions if required.

Q1) Attempt any two:

a)
  i) How do you interprete second law of Thermodynamics with Refrigeration? [4]

  ii) Discuss the limitations of Reversed Carnot cycle with gas a refrigerant. [4]

b) Necessity of cooling the Aeroplane. Discuss the internal and external heat sources contributing heat in Aeroplane compartment. [8]

c) The Carnot refrigerator requires 1.1 kw per tonne of refrigeration to maintain a region at a low temperature of -30°C. Determine; [8]

  i) C.O.P.

  ii) Higher temperature of the cycle.

  iii) The heat rejected in kJ per ton of refrigeration.

  Also calculate heat delivered and C.O.P when this device is used as heat pump.
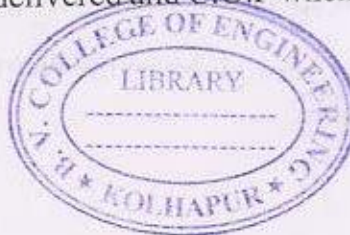
P.T.O.

2) Attempt any two:

a) Describe with help of a block diagram and P-h polt a vapour compression refrigeration system using a heat exchanger for both superheating and subcooling of a refrigerator. **[9]**

b) What do you mean by Cryogenic Engineering? Explain applications of cryogenics in various fields. **[9]**

c) A vapour compression refrigeration plant works between pressure limits of 5.3 bar and 2.1 bar. The vapour is super heated by 5°C before entering the compress the temperature at the end of isentropic compression is 37°C. Assume C_p of vapour refrigerant as 0.63 kJ/kg-k. Determine C.O.P. of the plant condition of refrigerant at end of condentation is saturated liquid properties of Refrigerant as follows: **[9]**

Pressure (Bars)	Temperature (ts°C)	Enthalpy of fluid (h & kJ/kg)	Latent heat h & g. kJ/kg
5.3	15.5	56.15	144.9
2.1	−14.0	25.12	158.7

3) Attempt any two:

a) Discuss why CFC refrigerants needs to be phased out. Explain the ozone depletion and global warming issues. **[8]**

b) Describe properties of a good refrigerants. **[8]**

c) Explain the working of evaporative type condenser with a neat sketch. **[8]**

4) Attempt any two:

a) Define relative humidity (ϕ), degree of saturation (μ), dew point temperature and adiabatic saturation temperature. Derive the relation between ϕ and μ. **[8]**

b) The moist air is at 30°C,. The dew point, temperature is 15°C. The total pressure is 1 bar, Use steam table and calculate ϕ and μ. **[8]**

c) With help of psychrometric chart explain adiabatic mixing of moist air with infected water spray. Write only the governing equations for enthalpy and specific humidity. Draw the condition line with the help of $\left(\dfrac{\Delta h}{\Delta w}\right)$ protector given on the chart. **[8]**

5) Attempt any two:

a) Explain the factors affecting By-Pass factor. Apparatus due point and coil rating with the help of psychrometric chart. Also write only the equations for air quantity over a coil using ESHF, ADP and B. F. **[9]**

b) Explain only the body regulatory process against heat and cold. Draw neat sketch of comfort chart giving the numerical values. **[9]**

c) Air conditioning system is used for a Bank with following details: **[9]**

No. of persons = 100.

Ventilation requirement 0.0047 m²/sec per person.

Out door design condition, DBT = 37°C, WBT = 27°C.

Indoor condition desired R. H. = 60% & DBT = 22°C

Room sensible heat load = 4,00,000 kJ/h.

Room latent heat load = 2,00,000 kJ/h.

By-pass factor = 0.15. Calculate:

Grand total heat, ESHF, A.D.P. amd quantity of detrumidified air supplied to the Bank.

6) Attempt any two:

a) Explain sources of heat load for air conditioning system. Write only essential equations. **[8]**

b) Explain duct sizing methods by using suitable charts. **[8]**

c) Explain room air distribution requirements. Write a note on types of outlets used for supply and distribution. **[8]**

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Seat
No.

B.E. (Mechanical) (Semester - VII) (New)
Examination, April - 2018
MECHANICAL SYSTEM DESIGN
Sub. Code : 67502

Day and Date : Wednesday, 25 - 04 - 2018
Time : 2.30 p.m. to 5.30 p.m.

Total Marks : 100

Instructions :
1) All questions are compulsory.
2) Assume suitable data wherever necessary and state it clearly.
3) Draw neat labeled sketches wherever necessary.

Q1) a) With suitable example, explain effect of symmetry and balance, surface finish, colour and harmony in aesthetic design. **[8]**

b) Explain importance of ergonomic considerations in the design of displays and controls in the dashboard of a car. **[8]**

OR

With suitable example explain the creativity concept in the product design. **[8]**

Q2) a) Explain with neat sketch various types of stresses acting in thin pressure vessels subjected to internal pressure. **[6]**

OR

Explain the different types of end closures used in pressure vessels as per IS 2825 - 1969. **[6]**

b) A cylindrical pressure vessel shell of inside diameter 1500 mm is subjected to an internal pressure of 2 MPa. The shell as well as heads are made of low alloy steel with an ultimate tensile strength of 450 N/mm². The double welded butt joints which are spot radiographed ($\eta = 0.85$), are used to fabricate the vessel. The corrosion allowance is 3 mm. Determine the thickness of the cylindrical shell and the thickness of the head if the heads are: **[12]**

i) Flat Head;

ii) Plain Formed;

iii) Hemispherical;

iv) Toro spherical with crown radius of 1125 mm;

P.T.O.

Q3) a) What is braking torque? Discuss various energy equations used in the design of Brakes. **[8]**

b) A multi-disk plate clutch consists of five steel plates and four bronze plates. The inner and outer diameters of the friction disks are 75 and 150 mm respectively. The coefficient of friction is 0.1 and the intensity of pressure on friction lining is limited to 0.3 N/mm². Assuming uniform wear theory, calculate: **[8]**

i) Required force to engage the clutch and

ii) Power transmitting capacity at 750 rpm.

OR

A four wheeled automobile car has a total mass of 1000 kg. The moment of inertia of each wheel about a transverse axis through its center of gravity is 0.5 kg-m². The rolling radius of the wheel is 0.35 m. The rotating and reciprocating parts of the engine and the transmission system are equivalent to a moment of inertia of 2.5 kg-m², which rotates at five times the road - wheel speed. The car is travelling at a speed of 100 km/h on a plane road. When the brakes are applied the car decelerates at 0.5g. There are brakes on all four wheels. Calculate: **[8]**

i) The energy absorbed by each brake.

ii) The torque capacity of each brake.

Q4) a) Explain the optimization of structural diagram in the design of a multi speed machine tool gear box. **[6]**

OR

Explain the advantages of geometrical progression for selecting the speed steps of a multi speed machine tool gear box. **[6]**

b) A three-stage, twelve speed gear box is to be designed for multi spindle speeds varying between 60 r.p.m. and 2880 r.p.m. The second stage consists three speed steps, if the gear box is driven by 5 kW, 1440 r.p.m. electric motor. Assume same module for all gears. **[12]**

i) Draw the speed ray diagram.

ii) Draw the gearing diagram.

iii) Determine the number of teeth on gears.

Q5) a) Explain step by step procedure for finding out the dimensions of the I-sections of the connecting rod. [8]

b) Determine the small and the big end bearings of the connecting rod for a diesel engine with the following data: [8]

i) Cylinder Bore = 80 mm

ii) Maximum gas pressure = 3 MPa

(l/d) ratio for piston pin bearings = 2

(l/d) ratio for crank pin bearing = 1.2

Allowable bearing pressure for piston pin bearing = 10 MPa

Allowable bearing pressure for crank pin bearing = 06 MPa

OR

The following data is given for a connecting rod:

Engine speed = 1500 rpm.

Length of connecting rod = 250 mm.

Length of stroke = 150 mm.

Density of material = 7800 kg/m³

Thickness of web or flanges = 6 mm

Assume the cross-section of the connecting rod as shown in figure for which Area of cross section. Calculate the whipping stress in the connecting rod.
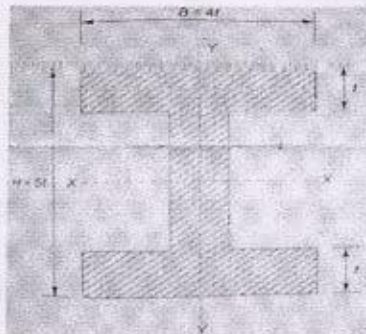
$(A) = 11t^2$, $I_{xx} = \left(\dfrac{419}{12}\right)t^4$ and $y = \left(\dfrac{5t}{2}\right)$. [8]

Q6) a) Explain Lagrange's Multiplier method for optimum design. [8]

OR

Explain the following terms in Johnson method of optimization. [8]

i) Primary Design Equation (PDE)

ii) Subsidiary Design Equation (SDE)

iii) Limit Equation (LE)

b) A shaft is to be used to transmit a torque of 1500 N-m. The required torsional stiffness of the shaft is 100 N-m/degree, while the factor of safety based on yield strength in shear is 2.0. Using the maximum shear stress theory, design the shaft with the objective of minimizing the weight, out of the following materials: [8]

Use following data for the materials.

Material	Weight Density (w) N/m³	Yield Strength (S_{yt}) MPa	Modulus of rigidity (G) N/mm²
Chromium steel	77×10³	420	84×10³
Plain carbon steel	76.5×10³	230	84×10³
Titanium Alloy	44×10³	900	42×10³
Magnesium Alloy	17.5×10³	225	15×10³

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