Q.No. | Question | M.M.  
--- | --- | --- 
1(a) | Discuss the meaning of quality for manufactured products, from the customer's point of view, and from the manufacturer's point of view. | [06]  
1(b) | How are various costs involved in the design and production of quality products? Explain with the help of an example. | [06]  

OR

1’(a) | A stamping machine produces can tops whose diameters are normally distributed with a standard deviation 0.2 mm. At what “nominal” (mean) diameter should the machine be set so that no more than 5% of the can tops produced have diameters exceeding 60 mm? | [06]  
1’(b) | A random sample of size 100 is taken from an infinite population having the mean as 76 and the variance 256. What is the probability of getting the sample mean between 75 and 78. | [06]  
2 | A process manufacturing a dimension with specification limits as 100 +/- 2 mm is to be monitored by x-bar and R charts. The process was not monitored till now by any charts. The only previous information possible is that the process mean was fairly accurately centred and that no more than 0.5% of the output was defective. It is desired that the chart should be prepared immediately and points plotted in real time. Prepare the chart and plot the following points on the chart and interpret the results. The samples were taken with a sample size of 5. What will be your
recommendations for future?

<table>
<thead>
<tr>
<th>Sample no.</th>
<th>x-bar</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100.03</td>
<td>0.06</td>
</tr>
<tr>
<td>2</td>
<td>99.98</td>
<td>0.04</td>
</tr>
<tr>
<td>3</td>
<td>99.93</td>
<td>0.02</td>
</tr>
<tr>
<td>4</td>
<td>99.95</td>
<td>0.03</td>
</tr>
<tr>
<td>5</td>
<td>100.01</td>
<td>0.05</td>
</tr>
</tbody>
</table>

3 A normally distributed quality characteristic is controlled through the use of an x-bar and R chart. These charts have the following parameters (n = 4):

<table>
<thead>
<tr>
<th>x-bar chart</th>
<th>R chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCL = 626.0</td>
<td>UCL = 18.795</td>
</tr>
<tr>
<td>Center Line = 620.0</td>
<td>Center Line = 8.236</td>
</tr>
<tr>
<td>LCL = 614.0</td>
<td>LCL = 0</td>
</tr>
</tbody>
</table>

Both charts exhibit control.

(a) What is the estimated standard deviation of the process?
(b) If specifications on the product were 610 +/- 15, what would be your estimate of the process fraction nonconforming?
(c) What could be done to reduce this fraction nonconforming?
(d) What is the probability of detecting a shift in the process mean to 610 on the first sample following the shift (std. dev. remains constant)?
(e) What is the probability of detecting this shift by at least the third sample after the shift occurs?

OR

3'(a) What are control charts for individual measurements? Under what conditions are they of special benefit? Explain with the help of an example.

3'(b) Write a note on the features and utility of Cumulative Sum and Exponentially Weighted Moving Average (EWMA) control charts. Give examples to explain.
4 Items manufactured by a process were coming for final inspection in the lots of 500 items each and were inspected by a single sampling plan \( n = 100; c = 0 \). Due to some convenience the lot size was reduced to 250 items and the inspectors changed the sampling plan to \( n = 50; c = 0 \). Find out how the worst quality that may go to the market may get affected due to this change.

OR

4'(a) Explain the meaning of instantaneous failure rate. How is it related to the exponential distribution and to Weibull distribution for failure times?

4'(b) Six components are functionally connected as shown below to make up a system. Find the overall reliability of the system, given that the reliabilities of A, B, C, D, E, and F are, respectively, 0.95, 0.8, 0.9, 0.99, 0.9, and 0.85.

\[
\text{Diagram}
\]

5 A system is made up of two components connected functionally in series. The first component can fail only while operating but the second component may fail while operating and also while idle. Assuming appropriate symbols, form the equations and expressions for obtaining the steady state availability of the system.
Question no. 1 is compulsory. 
Answer any five questions. 
Assume suitable data if missing. 
Notations used have their usual meaning. Draw neat sketches to support your answers.

Q.No. Question M.M. 
1(a) Discuss the following: [06]
   (i) Etchant use to machining the work in chemical machining.
   (ii) Wearing of the cutting tool during electro-chemical machining.
   (iii) Heat is generated during electro-chemical machining.
   (iv) Drilled holes through electron beam machining are tapered.
   (v) Dimensional accuracy is high when drilled through laser beam machining.
   (vi) All materials can employ plasma arc machining.

1(b) Write all the correct answers (more than one answer may be correct). [06]
   (i) Materials not suitable for making a nozzle employed in AJM process may be 
      (a) copper, (b) stainless steel, (c) sapphire, (d) WC.
   (ii) In AJM, mixing ratio is governed by amplitude and frequency of vibration of the sieve. The frequency of vibration of sieve is (a) 50-60 Hz, (b) 10-15 kHz, (c) above 15 kHz.
   (iii) In case of AJM, lower carrier gas pressure would yield (a) higher MRR and higher nozzle-life, (b) lower MRR and lower nozzle life, (c) higher nozzle life but lower MRR, (c) None of these.
   (iv) In AJM, with the increase in stand-off-distance, the width of cut (a) decreases, (b) increases, (c) remains constant.
   (v) During AJM, increase in mass flow rate of abrasive particles would (a) decrease the value of mixing ratio, (b) increase the value of mixing ratio, (c) no definite effect on mixing ratio.
   (vi) With an increase in abrasive particle size in AJM, (a) MRR as well as surface finish value increase, (b) MRR decreases but surface finish value increases, (c) MRR increases but surface finish value decreases.

2(a) In electro-chemical machining, discuss that the metal is removed atom by atom. [03]
2(b) Discuss the effect of feed during electro-chemical machining on the variation between the electrode gaps.

2(c) Discuss the effect of electro-chemical machining on the work materials.

3(a) Give the importance of electron discharge machining.

3(b) Develop an expression to estimate the metal removal rate through electro-discharge machining.

3(c) Discuss the effect of dielectric circulation on metal removal rate.

4(a) Explain the transparent layer in electron beam machining.

4(b) Develop a relation to estimate the speed of cutting in electron beam machining.

4(c) A 100 \( \mu \text{m} \) thick and 1.5 mm deep slot is to be cut in tungsten sheet through electron beam machining with a power of 7 kW. Determine the cutting speed. Assume volumetric specific heat, thermal conductivity and melting point of tungsten as 2.71 J/cm\(^3\)-K, 2.15 W/cm\(^2\)-K and 3400°C, respectively.

5(a) Determine the percentage change in the machining time for an USM (ultrasonic machining) operation cutting tungsten carbide plates when the tool material is changed from copper to stainless steel.

5(b) Glass is being machined at a MRR of 6 mm\(^3\)/min by Al\(_2\)O\(_3\) abrasive grits having a grit dia of 150 \( \mu \text{m} \). Determine the MRR when:

I. 100 \( \mu \text{m} \) grits were used.

II. The frequency is increased from 20 kHz to 25 kHz.

III. The feed force is increased by 50% along with a reduction in concentration by 70%.

5(c) Sketch and describe any two types of tool feed systems used in USM.

OR

5’ Discuss the hypothesis proposed by Shaw regarding the mode of material removal in USM and obtain an expression for machining rate. What are the assumptions on which this expression is based? How far these assumptions are valid?

6(a) Discuss why the AJM technique, when applied to ductile materials, leads to a low rate of metal removal.

6(b) Discuss the effects of the following parameters on working accuracy and the rate of metal removal in AJM:

I. Grain size  
II. Jet velocity  
III. Standoff distance
M.TECH. (WINTER SEMESTER) EXAMINATION  
(MECHANICAL ENGINEERING)  
MACHINE DESIGN  
MECHANISMS  
ME-632

Maximum Marks: 60  
Credits: 04  
Duration: Three Hours

Answer all the questions.  
Assume suitable data if missing.  
Notations used have their usual meaning.

Q.No.  

1(a) State and explain classification of Mechanisms. Draw two inversions of a reciprocating mechanism.  

1(b) In a four link mechanism, the dimensions of the links are as under:  

AB=50 mm, BC=66 mm, CD=56 mm and AD=100 mm, AD is the fixed link. At an instant when the $\angle DAC$ is 60°, the angular velocity of the input link AB is 10.5 rad/sec counter clockwise and the angular retardation is 26 rad/sec$^2$. Determine analytically the angular displacements.

2 Determine the lengths of the link of a four bar mechanism to generate $y = \log_{10} x$ in the interval $1 \leq x \leq 10$. The length of the smallest link is 5 cm. Use three accuracy points with Chebyshev’s spacing. 

OR

2' Using Bloch method of synthesis, synthesise a four bar linkage to give the following values for the angular velocities and accelerations $\omega_2 = 200 \text{ rad/sec}$, $\omega_3 = 85 \text{ rad/sec}$, $\omega_4 = 130 \text{ rad/sec}$, $\alpha_2 = 0 \text{ rad/sec}^2$, $\alpha_3 = -1000 \text{ rad/sec}^2$, $\alpha_4 = -1600 \text{ rad/sec}^2$. Also draw, to the scale, the synthesised link.

3(a) State and explain the three position synthesis of a four bar mechanism.  

OR

3(a') Derive Freudenstein’s equations for synthesising a four bar linkage.  

3(b) Consider a rigid four bar mechanism, taking link 1 as a fixed link, derive the expressions for dynamic equilibrium for links 2 and 3.  

4 Derive Euler-Savary equation for points between the instantaneous centre and the inflection point.  

Contd.......


The offset slider crank mechanism of Fig. 1 is driven by slider 4 at a speed of $V_c = 10$ m/sec to the left at the position shown. Determine the angular velocity of links 2 and 3 and the instantaneous velocity of point D. Use the method of kinematic coefficients.

Fig. 1

OR

Write short notes on the following:

(i) Brodell and Soni Chart for the design of the crank rocker linkage.
(ii) Grashof's Criterion of a four bar linkage.
(iii) The Bobillier Construction for locating the inflection circle.
(iv) Chebychev's spacing for precision points.
M.TECH. (WINTER SEMESTER) EXAMINATION
MACHINE DESIGN
EXPERIMENTAL STRESS ANALYSIS
ME-634

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question M.M.

1(a) What is the importance of experimental methods? [04]
1(b) Discuss the various methods of obtaining plane polarized light. [08]

OR

1'(a) What is temporary birefringence? [04]
1'(b) What is a Polariscope? Describe the basic elements of a Plane Polariscope. [08]

2(a) State the stress optic Law in two dimension and obtain an expression for the same. [08]
2(b) What are the important photoelastic materials used for making models? [04]

3(a) What do you mean by reinforcing effects of photoelastic coatings? [07]
3(b) An epoxy coating is bonded to an aluminium specimen. Determine the stress sensitivity index of the coating for the following data:

\[ E^S = 0.7 \times 10^5 \text{N/mm}^2, \sigma^S = 3.15 \times 10^3 \text{N/mm}^2, \nu^C = 0.36, \sigma_0 = 10.3 \text{N/mm}, \]
\[ h^C = 2.54 \text{mm} \]

OR

3' Explain the brittle coating method in brief. What are the advantages and limitations of this method? [12]

4(a) Discuss the crack patterns which can be obtained under various combinations of stresses. Illustrate your answer by giving sketches. [06]

4(b) Determine the stresses in a brittle coating applied to a component made of aluminium for which \( E^S = 70 \text{ GPa}, \nu^S = 0.33 \), when the specimen stresses are \( \sigma_1^S = 70 \text{MPa} \) and \( \sigma_2^S = 25 \text{MPa} \) for a resin based coating with \( E^C = 0.7 \text{GPa} \) and \( \nu^C = 0.36 \). [06]

5(a) What is a strain gauge? Also give the different types of strain gauges. [06]

Contd………2
OR

5'(a) Define a rosette. What are the different types of strain rosette configurations? [06]

5(b) A rectangular rosette when mounted on a structural member, produces the following strain indications with the application of load: \( \varepsilon_a = 1680 \times 10^{-6} \), \( \varepsilon_b = -1110 \times 10^{-6} \), \( \varepsilon_c = 620 \times 10^{-6} \). Calculate the principal strains, principal stresses and the maximum shear stress if \( \nu = 0.30 \) and \( E = 200 \text{ GPa} \).
Q.No. Answer any three questions from Section ‘A’ and any two questions from M.M.

SECTION ‘A’

1 Define adiabatic flame temperature with respect to constant pressure and constant volume processes. Calculate the adiabatic flame temperature for the reaction

\[ \text{H}_2 + \frac{1}{6} \text{O}_2 \rightarrow \text{Products} \]

Assume that the gases are burned adiabatically at one atmosphere. The final composition of the products H, H\text{2}, H\text{2}O and OH in terms of respective mole fractions is given as: 0.01446, 0.65486, 0.32927 and 0.00139.

2 Liquid propane (C\text{3}H\text{8}) at 25 °C, 1.2 kg/min enters a combustion chamber, where it is mixed and burned with 150% excess air which enters the chamber at 12°C. The combustion gases consisting of CO\text{2}, CO, H\text{2}O, O\text{2} and N\text{2} leave at 1200 K, 2 atm. Determine the equilibrium constant K\text{p} and express it in terms of number of moles and pressure P. If the equilibrium composition of the gaseous combustion products is: 3CO\text{2} + 7.5O\text{2} + 4H\text{2}O + 47N\text{2}, determine the heat transfer rate from the chamber. The equilibrium equation between CO\text{2}, CO and O\text{2} can be expressed as:

\[ \text{CO} \leftrightarrow \text{CO} + \frac{1}{2} \text{O}_2 \]

Assume H\text{2}O as inert gas. The amount of NO formed will be negligible and is neglected.

3 What are the factors which influence the laminar burning velocity. Calculate the laminar burning velocity of a stoichiometric propane-air mixture initially at 298 K and 1 atm using the theory of Mallard-Le Chatelier with a single step global reaction rate. Assume \( T_f \) and \( T_i \) as 2270 K and 743 K respectively.

\[ \text{C}_3\text{H}_8 + 5(\text{O}_2 + 3.76\text{N}_2) \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O} + 18.8\text{N}_2 \]

\[ \text{Reaction Rate } (RR) = -8.6 \times 10^{11} \exp(-30000/1.9877T)[n_f]^{0.1}[n_{O_2}]^{1.65} \]

\( x_f, p_f \) and molar concentration \( [n_f] \),

\( [n_{O_2}] = 5 [n_f] \), \( R_u = 82.05 \text{cm}^3\text{atm}/gmol\text{K} \)

The average \( (RR) \) in \( \text{kg/m}^3\text{s} \) can be determined at an average temp of 298 K and 2270 K assuming that the fuel and oxygen molar concentrations are half their initial values. Take: \( \alpha_f = 2.53 \times 10^{-4} \text{m}^2/\text{s} \) and \( \rho_f = 0.0726 \text{kg/m}^3 \).

Contd……
4 Explain the Rankine-Hugoniot curve. Considering the Rankine-Hugoniot equation given as: \( q = \frac{\gamma}{\gamma - 1} \left( \frac{p_2}{\rho_2} - \frac{p_1}{\rho_1} \right) - \frac{1}{2} (p_2 - p_1) \left( \frac{1}{\rho_1} + \frac{1}{\rho_2} \right) \); Derive the relation: \( p_2 - p_1 = q (\gamma - 1) \rho \). Determine the detonation pressure \( p_2 \) for the reaction, \( \text{H}_2 + \frac{1}{2} \text{O}_2 \rightarrow \text{H}_2\text{O}(g) \). The initial pressure and temperature are 0.2 MPa and 298 K. The final density is assumed three times the initial density due to the formation of detonation wave. \( q \) is the heat release. Take \( \gamma = 1.4 \) and initial density as 0.96 kg/m\(^3\).

SECTION ‘B’

5(a) Differentiate between premixed and non premixed flames. Explain the different regimes of a Bunsen burner flame.

(b) Briefly discuss the formation of thermal, prompt and fuel bound NO.

6(a) What is \( d^2 \)-law of droplet combustion. Draw \( d^2 \) versus time plot for (i) steady state droplet combustion, (ii) steady state combustion with convection, (iii) droplet heating and (iv) droplet heating with thermal expansion.

(b) Draw and explain the variation of temperature and species concentration profiles for a spherically symmetric droplet combustion model with and without droplet heating.

7 A 100 \( \mu \)m diameter, liquid ethanol droplet burns in stagnant air at 0.1 MPa and 300 K. Assuming the adiabatic flame temperature, calculate the temperature dependent properties and then determine; (i) heat transfer number, (ii) burning constant, (iii) burning rate, lifetime and (iv) flame stand off ratio, for steady state combustion. How will you modify the problem for the case of pure vaporization in a hot ambience.
Maximum Marks: 60  
Credits: 04  
Duration: Three Hours

Answer any four questions. 
Assume suitable data if missing. 
Notations used have their usual meaning.

Q.No.  
Question  
M.M.  
1  
With suitable assumptions and neat diagram, obtain Integral Energy Equation for the steady axial fluid flow over a body of revolution whose temperature and free stream velocity vary in an arbitrary manner. Reduce this equation for the 2D energy flow with constant free stream velocity and constant fluid to surface temperature difference.  
[15]  
2  
Derive the energy equation for constant wall heat flux and fully developed flow in a circular tube. Assuming heat conduction only in the radial direction, obtain relation for temperature distribution and Nusselt number.  
[15]  
3  
Using similarity solutions, obtain relations for temperature distribution and local Nusselt number for laminar thermal boundary layer over a semi-infinite plate under the conditions of constant free stream velocity and surface temperature.  
[15]  
4  
With neat diagrams, show flow patterns on a family of wedges. Obtain similarity solution for a 2D laminar incompressible external boundary layer with constant fluid properties, while the free stream velocity varies as: \( U = Cx^m \). Discuss the effect of blowing or suction of the fluid over the surface of flow.  
[15]  
5  
With suitable assumptions, derive the heat transfer equations for laminar film-wise condensation over an inclined plane, considering also the effect of condensate subcooling. Also, obtain the non-dimensional form of the heat transfer equation.  
[15]  
6  
Showing expected velocity and temperature profiles over a heated surface, briefly discuss the phenomenon of natural convection. Obtain the following relation for heat transfer during free convection over a constant temperature vertical flat plate.  
\[
NuGr^{1/4} = -\frac{1}{\sqrt{2}} \theta'(0); \quad \text{where} \quad \theta(\eta) = (T - T_\infty) / (T_e - T_\infty)
\]

[15]
2012-2013
II Semester M. Tech. Examination
Mechanical Engineering (Thermal Sciences)
I. C. Engines (ME 648)
Maximum Marks 60  Duration: Three Hours

(i) Attracts any Five Questions
(ii) All Questions are of Equal Marks
(iii) Use of Property Tables and Charts is allowed
(iv) All Symbols have Usual Meaning

1  Explain in detail the classification of Engines on the basis of
   (a) Spark Ignition Combustion 4
   (b) Compression Ignition Combustion 4
   (c) Continuous Combustion. 4

2  Describe in detail the concept of premixed combustion, which actually leads to excessively emissions of NO, UHC and CO in a conventional SI engine. 4x3

3  Describe in detail the concept of diesel combustion by using ROHR curve and explain the mechanism of the formation of rather excessively high amount of NO and TPM in HSDI diesel engine. 12

4  (a) Explain the concept of Direct Injection (DI) in SI Engine. 6
   (b) Explain why DI-SI engine is more efficient than MPFI Engine? 6

5  What is the disadvantage of Premixed Burning after the completion of Ignition Delay in HSDI diesel engine? Explain in detail the advantage of using multiple injections in a CRDI System for simultaneously reducing emissions of NO and TPM in a modern diesel engine. 12

6  Explain in detail various designs of combustion chambers generally used in
   (a) DI Diesel Engines 8
   (b) IDI Diesel Engines 4

7  Write detailed notes on any four
   (a) 3-Way Converter  (b) 2-Way Oxidation Converter  3x4
   (c) Turbocharger  (d) Thermal Reactor  (e) Use of VCO Nozzles in HSDI diesel engines  (g) OHC engines.
2012-13  
M.TECH. (WINTER SEMESTER) EXAMINATION  
MECHANICAL ENGINEERING (IND. & PROD. ENGG.)  
FLEXIBLE MANUFACTURING SYSTEM  
ME 655  

Maximum Marks: 60  
Credits: 04  
Duration: Three Hours  

Answer any FIVE questions.  
Assume suitable data if missing.  
Notations used have their usual meaning.

Q.No.  Question  M.M.  

1  Justify and/or refute the following, with examples.  
   "Time based competitiveness in dynamic and variety driven production systems,  
demands that computers be used to improve the efficiency of all activities. Hence  
Flexible Automation is the key to the success for FMS."  
[12]  

2(a)  What are Flexible Manufacturing Systems (FMS)? Show the relationships between  
various manufacturing flexibility types and also explain the measures of two most  
important types in FMS context.  
[06]  

2(b)  Discuss the role of the following in a CIM environment: Group Technology,  
Cellular Manufacturing and FMS.  
[06]  

3(a)  Explain with neat sketch and example the alternative approaches to FMS.  
[06]  

3(b)  Outline key design, planning, scheduling and control decisions required in FMS.  
[06]  

4  With respect to robot, explain the following:  
   i) Degree of freedom, ii) Accuracy, iii) Repeatability, iv) Sensors, v) Spatial  
   resolution and vi) Work envelope  
[12]  

5(a)  Explain briefly different method of classifying parts to form part families in GT  
context. Differentiate between mono-code and poly-code with the help of suitable  
examples.  
[06]  

5(b)  An automated guided vehicle system has an average travel distance per  
delivery=200m and an average empty travel distance=150m. Load and unload times  
[06]  

Contd……….2
are each 24 sec. and the speed of the AGV=1 m/sec. traffic factor=0.9. How many vehicles are needed to satisfy a delivery requirement of 30 del/hr. Assume Availability=0.95.

An FMS consists of four stations. Station 1 is load/unload station with one server. Station 2 performs milling operations with three servers (three identical CNC milling machines). Station 3 performs drilling operations with two servers (two identical CNC drilling machines). Station 4 is an inspection station with one server that performs inspections on a sampling of parts. The stations are connected by part handling system that has two work carriers and whose mean transport time = 3.5 minutes. The FMS produces four parts A, B, C, and D. The part mix fractions and process routings of the four parts are presented in the table below. The operation frequency f_{ijk} = 1. Determine (a) maximum production rate of the FMS, (b) corresponding production rate of each part, (c) utilization of each station in the system, and (d) the overall FMS utilization.

<table>
<thead>
<tr>
<th>Part j</th>
<th>Part Mix $p_i$</th>
<th>Operation $k$</th>
<th>Description</th>
<th>Station $i$</th>
<th>Process Time $t_{ijk}$ (min)</th>
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</thead>
<tbody>
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<td>Load</td>
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<td>3</td>
<td>15</td>
</tr>
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</tr>
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<td>Load</td>
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<td>3</td>
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<td>Drill</td>
<td>3</td>
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<td>Inspect</td>
<td>4</td>
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</tr>
<tr>
<td></td>
<td></td>
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<td>Unload</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
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<td>1</td>
<td>Load</td>
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<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Mill</td>
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<td>30</td>
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</tbody>
</table>

7(a) An AGVs has an average loaded travel distance per delivery = 400 m. The average empty travel distance is not known. Required number of deliveries per hour = 60. Load and unload times are each 0.6 min. and the AGV speed = 125 m/min. Anticipated traffic factor = 0.80, Availability = 0.95. Develop an equation that relates the number of vehicles required to operate the system as a function of the average empty travel distance.

7(b) Define decision support system. What are the different types and categories of decision support system? Explain them with the help of examples.
2012-13
M.TECH. (II SEMESTER) EXAMINATION
Industrial and Production Engineering
Ergonomics
ME658

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer any five questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q. No.  Question  M.M.
1.  a) Explain the information processing model of memory. How the sensory  [06]
    memory is different from short term memory.
b) List the key elements of high work load tasks. Explain the basic approaches  [06]
    for measuring mental workload.

2.  a) What is visual acuity? Differentiate between minimum perceptible Acuity  [06]
    and minimum separable acuity.
b) Under what conditions analogue displays are preferred over digital displays?  [06]
    What are the basic features of quantitative displays?

3.  a) List and explain the factors affecting manual material handling system.  [06]
b) What are the various tasks involved in the resection of auditory signal?  [06]
    Explain the principles of auditory display.

4.  a) What are the effects of noise on task performance? Suggest a cost effective  [06]
    ways of reducing noise in a factory having an ambient noise level of 100 dB
    (A).
b) Explain the difference and importance of physiological strain measurements  [06]
    using objective methods and subjective methods.

5.  a) How the data of EMG signal is used for evaluating muscles’ effort and  [06]
    fatigue for a task involving gripping?
b) How to calculate work-rest periods using Murrell’s principle? A worker  [06]
    weighing 90kg has a V O₂ max of 50mL O₂/kg/min. His work requires him

Contd......2
to metabolise 2.5 L of $O_2$/min. Specify approximately the maximum time he should be allowed to work without rest.

<table>
<thead>
<tr>
<th>Relative work demand (VO2 max)</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Working time</td>
<td>11 hr.</td>
<td>5:30 hr min</td>
<td>2:40 hr min</td>
<td>1:20 hr min</td>
</tr>
</tbody>
</table>

6. a) Explain the method of calculating Lifting Index using NIOSH equation.

b) Explain basic ergonomic requirement for work chair design.

7. a) Explain using flow chart the selection algorithms to assign a specific wheelchair to individuals.

b) How anthropometric data is used in Ergonomics Design?

8. a) Discuss health hazards due to exposure of hand arm vibration and whole body vibration.

b) Explain in brief the measurement procedure of Human exposure to vibration using ISO2631 and ISO5349.
Answer any five of the following questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question

1. Differentiate between Combined and Cogeneration cycles. What are the major advantages of a Combined cycle system in the present power picture of the world? Discuss the layout of the Binary vapour cycle with superheat. Why Mercury is used as the working fluid?

2. A combined gas turbine and steam turbine plant is to be designed to develop 200 MW power. The gas turbine plant works on open cycle and steam plant works on closed Rankine cycle. The air is supplied to the gas turbine plant at 15 °C and the maximum temperature of the cycle is 750 °C. The pressure ratio is 7.5. The temperature of the exhaust gases from gas turbine plant is raised to 750 °C by burning additional fuel in the secondary combustion. The gases leave the secondary combustion at 100 °C. The steam is generated at 50 bar and 600 °C and expands in the steam turbine upto 0.1 bar pressure. Take calorific value of fuel as 43300 kJ/kg, \( C_p = 1.11 \text{ kJ/kgK} \), and \( \gamma = 1.33 \) for gases

\[ C_p = 1.005 \text{ kJ/kgK} \text{ and } \gamma = 1.4 \text{ for air}, \text{Neglect the fuel mass and pump work.} \]

Find out (a) the mass of air and steam supplied per second (b) power output by gas turbine and steam turbine separately (c) the overall efficiency of the plant. Draw the plant layout.

3. Differentiate between Pressurized water reactor and Boiling water reactor. With neat sketches, discuss the working of both type of reactors. Discuss doubling time in a...
fast breeder reactor.

4 With neat sketches, discuss the working of a Benson and a supercharged boiler. Discuss the advantages of High pressure boilers. [12]

5 Keeping in view the operating and fixed costs of a power station, suggest some suitable tariffs. The maximum load on 2500 kW capacity diesel plant is 1600 kW. The load factor is 0.48. taking the following data, find out the cost of generation in Rs. per kWh, Installation cost = Rs. 18000/kW, Interest on capital = 15%, Maintenance cost = Rs. 200000/year, Total labour and other consumables = Rs. 850000/year, Fuel cost = Rs. 7/kg, Lubricating oil cost = Rs. 30/kg. Fuel consumed = 0.25 kg/kWh, Oil consumed = 0.025 kg/kWh. [12]

6(a) Draw and discuss the performance characteristics of a gas turbine plant showing the effect of the following parameters with pressure ratio on the thermal efficiency of the cycle:
   (i) regenerator effectiveness
   (ii) turbine inlet temperature
   (iii) combined intercooling-regeneration-reheat processes [06]

6(b) A gas turbine power plant consists of a two stage compressor with intercooling and a single stage turbine with a regenerator. Air enters the compressor at 1 bar and 20 °C. The maximum temperature of the cycle is limited to 900 °C and the maximum pressure ratio is 6. The effectiveness of the regenerator is 0.7. The rate of air flow through the plant is 210 kg/s and the calorific value of the fuel used is 40.8 MJ/kg. The isentropic efficiency of both the compressors and both the turbines are 0.82 and 0.92, respectively. The combustion efficiency is 0.95. Assuming the perfect intercooling and neglecting pressure and heat losses, determine
   (i) the air-fuel ratio
   (ii) the cycle efficiency
   (iii) the power supplied by the plant
   (iv) specific fuel consumption of the plant and the fuel consumption per hour

Take, for air \( C_p = 1.005 \text{ kJ/kgK} \) and \( \gamma = 1.4 \)

   for gas \( C_p = 1.08 \text{ kJ/kgK} \) and \( \gamma = 1.33 \) [6]

7(a) Give advantages and disadvantages of Gas Turbine plants over Diesel engine plant and Steam turbine plants [6]

7(b) What are the methods used for gas turbine blade cooling? Explain with the help of neat sketches. [6]
Maximum Marks: 60  
Credits: 04  
Duration: Three Hours

Answer any five questions.
Assume suitable data if missing.
Notations used have their usual meaning.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Questions</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>What are the possible causes of friction? Show that the modified adhesion theory of friction predicts large scale junction growth and high coefficient of friction.</td>
<td>[06]</td>
</tr>
<tr>
<td>1(b)</td>
<td>Discuss adhesion theory of metals with contaminant films. Write the condition of gross sliding and hence derive the expression for coefficient of friction. Draw the plot of coefficient of friction against relative strength of the interface and discuss some salient features.</td>
<td>[06]</td>
</tr>
<tr>
<td>2.</td>
<td>Derive the equations for pressure distribution and load carrying capacity for a long journal bearing.</td>
<td>[12]</td>
</tr>
<tr>
<td>3.</td>
<td>Using a suitable sliding drive system. Describe the stick slip phenomenon. Derive the equation of motion for the driven mass for small velocity variations. Draw the acceleration, velocity and displacement curves for the mass. A machine derive system with a mass 250 Kg and stiffness $10 \times 10^6$ N/m. Calculate the approximate value of dashpot coefficient to give the overall damping ratio 0.2 in regard to a small amplitude transient oscillations occurring at a speed of 0.003 m/s, assuming that the friction-velocity varies linearly with following results</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i) at $v=0.002$ m/s , $\lambda=2500$ Ns/m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(ii) at $v=0.004$ m/s , $\lambda=1500$ Ns/m</td>
<td></td>
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<tr>
<td></td>
<td>where $\lambda$ is gradient of friction-velocity curve.</td>
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</tr>
</tbody>
</table>

Contd………..2
4 (a) Drive the equation of frictional force in an inclined pad slider bearing.

(b) The following data refer to a pivoted shoe slider bearing:
- Width of the shoe = 100 mm
- Length of the shoe = 120 mm
- Velocity of the moving member = 3 m/s
- Lubricant viscosity = 0.02 Pas
- Permissible film thickness = 0.025 mm

Determine the maximum load carrying capacity, frictional force on the moving member and coefficient of friction at full load.

5 (a) Two long parallel flat plates of width B are approaching each other. Find the expressions of load carrying capacity and time ‘t’ required to reduce the oil film thickness from $h_1$ to $h_2$.

(b) A 120 mm diameter pad is supported on a flat circular plate by a film of 0.025 mm thick. In what period of time the film thickness decreases to 1/5 of the original value. Viscosity of the oil film at the operating temperature is 20 mPas.

6. Discuss various types of wear. Establish Archard’s equation of wear and hence write the laws of wear. Also, discuss Row’s modified adhesion theory which includes the effects of the surface films.

7. (a) Write the characteristics of the compensated bearings.

(b) State Darcy’s law governing the velocity of viscous fluid flow through a porous medium.

(c) Discuss thermal effects in hydrodynamic lubrication.

(b) Write the different types of additives and their characteristics for which they are used.
Answer any five questions.

1. What do you mean by composite materials? Give its classification and further explain in brief
   (i) Fibres
   (ii) Whiskers
   (iii) Bi metals
   (iv) Clad metals
   (v) Plastic based laminates

2. Explain stiffness, Compliance and Engineering constants for orthotropic materials with the help of equations.

3. What do you mean by Biaxial strength criteria for an orthotropic Lamina? Further explain any two of the following.
   (i) Maximum stress failure criterion.
   (ii) Maximum Strain failure criterion.
   (iii) Tsai-Hill failure criterion.

4. By using the Mechanics of material approach to stiffness, write the method of determination of any three of the following
   (i) Young’s modulus ‘E₁’ in the direction of fibre
   (ii) Young’s modulus ‘E₂’ in the transverse direction to fibres

Contd......2
(iv) Poisson's Ratio \( \gamma_{12} \).

(v) Shear Modulus \( G_{12} \).

5. Explain in brief the bounding techniques of Elasticity. Further explain any one of the following:
   (i) Lower bound on Apparent Young's Modulus
   (ii) Upper bound on Apparent Young's Modulus

6. What do you mean by Thermal and Mechanical Stress Analysis, explain in detail with the help of equations.

7(a). Give the restrictions, assumptions and consequences of the equation for bending of laminated plates.

7(b). What do you mean by deflection of simply supported laminated plates under distributed transverse load? Also explain any one of the following cases (a) the deflection of especially orthotropic laminated plates (b) the deflection of antisymmetric Cross-ply laminated plates.
Question 1(a) Consider two lines passing through the origin with slopes \( m_1 \) and \( m_2 \) respectively and show that if two pure reflection transformations about these lines are applied successively, the result is a pure rotation about the origin. Find the angle of rotation.

Question 1(b) Develop a general form of scaling transformation matrix about a fixed point \((m, n)\).

OR

Question 1'(a) A mirror is placed such that it passes through \((2, 0)\) and \((0, 2)\). Find the reflected view of a triangle with vertices \((3, 4), (5, 5)\) and \((4, 7)\) in this mirror.

Question 1'(b) Show that the product of sequential reflections about two parallel lines, \(x = a\) and \(x = b\), of a point \((x, y)\) is the equivalent of a single translation. Find the amount of translation.

Question 2(a) Define Viewing Transformation. Find the transformation for window to viewport which uses the rectangle whose lower left corner is \((x_{w_{min}}, y_{w_{min}})\) and upper right corner is \((x_{w_{max}}, y_{w_{max}})\) as a window and the viewport that has lower left corner at \((x_{v_{min}}, y_{v_{min}})\) and upper right corner at \((x_{v_{max}}, y_{v_{max}})\).

Question 2(b) Generate a parametrically represented ellipse with semi major axis \(a = 6\) and semi minor axis \(b = 2\) inclined at 45° to the horizontal with its centre at \((4, 4)\).

Question 3 What is the sequence of transformations required for rotating an object about an arbitrary axis in space? Consider an arbitrary axis passing through a point \((x_0, y_0, z_0)\) with direction cosines \((c_x, c_y, c_z)\). Find the matrices of all the sequential
transformations for rotation of an object about this axis by an angle $\delta$.

4 Define isometric projections. How is it different from dimetric projections and trimetric projections? Show that for an isometric projection, $\theta = \pm 35.26^\circ$, $\Phi = \pm 45^\circ$ and $f' = 0.8165$, where $\Phi$ is the rotation about the $y$-axis, $\theta$ is the rotation about the $x$-axis and $f$ is the foreshortening factor.

OR

4' Consider a tetrahedron ABCD as follows:

$$ABCD = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}$$

Determine its orthographic projection on to the $xy$-plane after rotating it by $45^\circ$ about a line passing through the origin which is equally inclined to all the coordinate directions.

5(a) Define the following

(i) Isoparametric formulation

(ii) Properties of global stiffness matrix

(iii) Element Connectivity

5(b) Using potential energy approach, determine the displacements of nodes of the spring system shown in Fig.1.

![Fig.1](image-url)
2012-13
M.TECH. (WINTER SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
(Industrial & Production)
FOUNDRY TECHNOLOGY
ME 759

Maximum Marks: 60

Credits: 04

Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning. Draw neat sketches to support your answers.

Q.No.

1(a) Name the various stages of shrinkages during solidification of molten metal in green sand mould. Give the measures taken to overcome the dimensional changes occurred in the casting during these stages of solidification.

1(b) Draw the neat sketch of the pattern and the core (if necessary) for an hollow cylindrical casting, inside diameter is 75 mm and outside diameter is 65 mm, with a hole of 25 mm diameter on its surface at the centre. Take total liquid volumetric shrinkage and total solid volumetric shrinkage as 6.5% and 4.0% respectively.

2(a) Name the ingredients of green sand mould. Discuss the effect of (i) particle size of sand (ii) moisture content and (iii) permeability on the properties of steel casting.

2(b) Name the equipments used to melt steel for casting. Discuss their limitations and usage.

3(a) What are equi-axed grains, columnar grains and dendrite growth? Discuss their formation during solidification of molten metal. Discuss the effect of dendrite formation during solidification on the sound casting.

3(b) Discuss the solidification of eutectic alloys.

4(a) Differentiate the functioning of pouring basin, down-sprue, riser and runner in gating system.

4(b) What are pressurized and non-pressurized gating systems? Discuss the procedures to achieve them.

Contd…….2
4(c) Design a blind riser for the given steel casting.

All dimensions are in mm. Assume missing data.

5(a) Differentiate between shell moulding and skin-dried moulding.

5(b) Discuss in detail the moulding of an aluminium hollow cylindrical heat sink with fins on its curved surface. Give assembly diagram of the mould cavity.

6 What is S.G. iron? Discuss its properties. Discuss the measures taken to produce castings of S.G. iron.

7 What is meant by mechanization of foundry? Discuss the factors involved in the mechanization of foundry. Discuss in detail the mechanization of moulding-line.
2012-13
M.TECH. (WINTER SEMESTER) EXAMINATION
( THERMAL ENGINEERING)
SOLAR ENERGY
ME-763

Maximum Marks: 60 Credits: 04 Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question

1 Explain: (i) Clearness index and Solar constant.
   (ii) Spectral distribution of extraterrestrial solar radiation and Wavelength
   range of solar radiation on earth’s surface.

2 With appropriate diagrams, derive the relation for useful heat gain in terms of the
   heat removal factor and fluid inlet temperature for a liquid flat plate solar collector.
   Write the assumptions made.

OR

2' Calculate the angle of incidence, optical efficiency and overall heat loss coefficient
   for a flat plate collector of size 2 m x 1 m with single glass cover located at Pune
   (18°32’ N, 73°51’ E) on 19th May at 11:30 A.M. with a tilt angle equal to latitude
   angle towards south. The glass is 4 mm thick and has thermal conductivity 0.78
   W/m-K, extinction coefficient 19.0 m⁻¹, emissivity/absorptivity 0.88. Refractive
   index of glass relative to air 1.526. The absorber plate has selective coating. The air
   gap spacing between the absorber plate and glass cover is 25 mm. The intensity of
   beam and diffuse radiations are 725 W/m² and 230 W/m². Reflectivity of the
   surrounding surfaces 0.2. Wind velocity is 1.5 m/s. Mean temperature of the
   absorber plate, glass cover and ambient air are 80 °C, 40 °C and 25 °C respectively.
   Back and side insulations are 80 mm and 40 mm with k_\text{ins} = 0.04 W/m-K.

3(a) Derive the expression for transmissivity of cover system of a flat plate solar
    collector based on reflection-refraction and absorption of beam radiation.

OR

Contd........2
3(a) With the help of schematic diagram, describe the complete test procedure of a liquid flat plate solar collector.

3(b) With the help of a neat sketch show the main components of a box type solar cooker and write the name of the materials used for each component.

4(a) Derive the expression for useful heat gain for cylindrical parabolic collector. Write the assumptions made.

4(b) Discuss the working of a cabinet type solar dryer.

OR

4' A conventional solar air heater with continuous longitudinal fins fixed to the bottom side of the absorber plate of size 2m x 1m, having space between absorber and bottom plate 15 mm. The air flow rate and inlet temperature are 200 kg/hr and 50 °C, respectively. The ambient is at 20 °C and insolation on collector face is 950 W/m². The top and bottom loss coefficients are 6.2 W/m²K and 0.8 W/m²K, respectively. The emissivity of the absorber and bottom plate is 0.95 each. The value of (εα)avg is 0.85. The centre to centre distance between fins is 2.5 cm. The fin height and thickness are 1.3 cm and 0.3 cm, respectively. Assume for the sake of simplicity that the value of radiative heat transfer coefficient does not change because of the presence of fins. Neglecting heat loss from the side, calculate: Air outlet temperature, instantaneous efficiency and pressure drop.

Take Nu = 0.023Re⁰.⁸Pr⁰.⁴ and f = M Re⁴²

where M = 0.04(2.058 -{(L-Lf)/L})⁰.³¹³ and N = 0.075[3.40 -{(L-Lf)/L}]⁰.⁷¹¹.

5(a) Describe the construction and working of solar pond.

5(b) With neat sketches describe the active and passive methods for space heating.

Data sheet: \( \sigma = 5.669 \times 10^{-8} \text{ W/m}^2\text{K}^4 \); Allahabad (25°28' N, 82°30' E)

\[
\begin{align*}
\cos \theta &= \sin \delta \sin \phi \cos \beta - \sin \delta \cos \phi \sin \beta \cos \gamma + \cos \delta \cos \phi \cos \beta \cos \omega \\
&+ \cos \delta \sin \phi \sin \beta \cos \gamma \cos \omega + \cos \delta \sin \phi \sin \gamma \sin \omega \\
E &= 9.87 \sin 2B - 7.53 \cos B - 1.5 \sin B, \text{ where } B = 360(n - 81)/364 \\
Nu &= 0.229 \left( Ra \cos \beta \right)^{0.252} ; \quad h_w = 5.7 + 3.8 V_w 
\end{align*}
\]

The properties of air at 60 °C are: \( k = 0.029 \text{ W/m-K}, \nu = 18.97 \times 10^{-6} \text{ m}^2/\text{s}, \)

\( \text{Pr} = 0.696, \quad \rho = 1.060 \text{ kg/m}^3, \quad c_p = 1.005 \text{ kJ/kg-K}. \)