NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MEC401

Course Name: Design of Machine Element

Full Marks: 30

Time: 90 Minutes

Question Paper No.: NITDGP/MEC401/1

Date of Exam: 25/04/2022

Group A: Answer Any FIVE questions from Group A.

Question No.	Body of the Question	Marks	Mapped CO
1	What do you understand from the term "Endurance limit of materials"? Explain with the help of any S-N diagram.	3	CO4
2	Distinguish between "thin cylinder" and "thick cylinder" with the help of suitable examples.	3	CO3
3	State and explain Miners rule of cumulative fatigue damage for high-cycle fatigue.	3	CO4
4	What do you understand from the term "notch sensitivity"? Establish an analytical relation between notch sensitivity and fatigue stress concentration factor.	3	CO4
5	Derive an analytical expression for the wall thickness of a thick cylinder made of any ductile material. Assume that the ends of cylinder are open and the cylinder is subjected to internal pressure only. Neglect the effect of outside pressure and that of welded joint.	3	CO3
6	Write a short notes on (any one): a) Compounding of cylinders b) Soderberg Line	3	CO3
7	An air receiver, consisting of a cylindrical shell closed by hemispherical ends, is made of plain carbon steel 20C8 and has a storage capacity of 0.3 m^3. The Inner Diameter of the cylinder is half of the length of the straight cylindrical portion which is of uniform diameter. The operating pressure is limited to 5 MPa. Assume that the ultimate tensile strength of steel 20C8 is 390 MPa. Use a factor of safety of 4. Determine the wall thickness of the cylinder.	3	CO3

Course Outcomes

CO1 Acquire an idea about engineering materials in machine design

CO2 To learn the basic design procedure for different elementary machine elements

CO3 To learn about design of bolt and welded joints, pressure vessels etc.

CO4 Introduction to fatigue design

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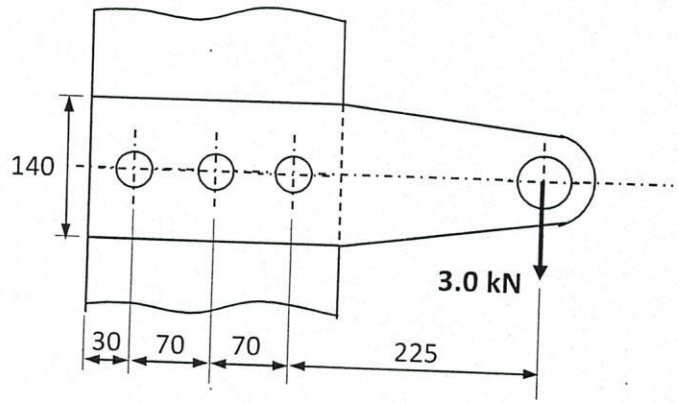
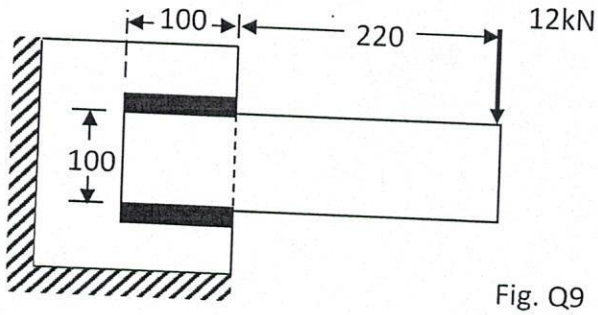
Group B: Answer Any THREE questions from Group B.

Question No.	Body of the Question	Marks	Mapped CO
8	(a) Mention important advantages of coarse series thread and fine series thread. Give their standard designation in metric system (b) A steel plate subjected to a force of 3.0 kN and fixed to another plate by means of three identical screws is shown in fig. Q8. The screws are made from plain carbon steel 45C8 (Yield stress=380 MPa) and the factor of safety is 2.5. Specify the size of screws.  All dimensions are in **mm** **Fig. Q8**	**2+3=5**	CO3
9	(a) What are the four basic elements of weld symbol? (b) A weld joint as shown in fig. Q9 is subjected to an eccentric static force of 12kN. Determine the size of weld if permissible shear stress for the weld is 90 MPa.  Fig. Q9 All dimensions are in **mm**	**1+4=5**	CO3

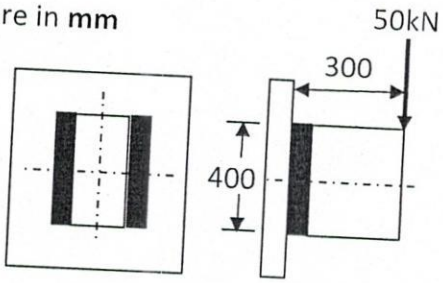
Course Outcomes

CO1 Acquire an idea about engineering materials in machine design

CO2 To learn the basic design procedure for different elementary machine elements

CO3 To learn about design of bolt and welded joints, pressure vessels etc.

CO4 Introduction to fatigue design

10	(a) What is surge in spring? (b) What is the purpose of heli-coil in the threaded joint? (c) The rear axle suspension of a heavy vehicle is provided with a semi-elliptic multi-leaf spring. The spring has 1 master leaf, 7 graduated length leaves and 2 extra full length leaves. The distance between the two eyes of the master leaves is 1000 mm. The central load is estimated to be 24 kN. The width of the steel strip is given as 80 mm. The yield strength of the spring steel is 1480 MPa and Young's modulus is 207000 MPa. Assuming a factor of safety 2, determine the thickness of the spring leaves and the central deflection under the given load.	**1+1+3=5**	CO2
11	(a) What is the purpose of shot peening in spring manufacturing? (b) A railway wagon has to be provided with two buffers containing identical closely coiled helical compression springs in parallel arrangement. The wagon which weights 2000 kg has a travel speed of 2 m/sec when it touches the buffers and comes to rest. The springs are compressed by 200 mm in bringing the wagon to rest. The springs are made of oil-hardened and tempered steel wire with ultimate tensile strength of 1250 MPa and modulus of rigidity of 81370 MPa. The permissible shear stress for the spring wire may be taken as 50% of the ultimate tensile strength. Assuming a spring index of 6, calculate the following : (i) wire diameter, (ii) mean coil diameter, (iii) number of active coils in each spring,.	**1+4=5**	CO2
12	(a) Draw the sketch of a multi-leaf spring and mark all the parts. (b) A bracket is welded to the vertical plate by means of two fillet welds as shown in fig. Q12. Determine the size of the welds, if the permissible shear stress is limited to 70 N/mm^2. All dimensions are in **mm**  Fig. Q12	**2+3=5**	CO3

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MEC402

Course Name: Casting, Forming and Welding

Question Paper No.: NITDGP/MEC402/1

Full Marks: 30

Time: 90 minutes

Date of Exam: 26/04/2022

Instructions: Answer all questions. Make a neat and well labeled diagram wherever necessary.

Materials to be supplied: NIL

Question No.	Body of the Question	Marks	Mapped CO
1	List any 5 welding defects. Draw a neat diagram for all of them and also write the causes and remedies for those defects.	5	CO3
2	List any 5 products/components which is manufactured through any of the Forming operations and also write the name of the Forming operation that is used for their manufacture.	5	CO4
3	In one line, distinguish between : a.) Direct Extrusion and Indirect Extrusion b.) Billet and Bloom c.) Plates and Strips d.) Hot working and Cold Working e.) Closed die forging and Precision Forging	1X5 = 5	CO4
4	Distinguish between top gate and bottom gate in tabular format in respect of their application, thermal gradient and turbulence of flow. Also make necessary sketch.	5	CO1
5	Mention three major defects found in casting. Highlight the reason for the occurrence and also suggest specific modification to avoid/minimize those defects	5	CO1
6	A cast iron slab of 500x200x40 mm is to be cast through top gate and sprue height is 100mm.. Calculate choke area. Given Pouring time=$K[1.41+(T/14.59)]\sqrt{W}$ for cast weight less than 450kgs. where K=22/40 Efficiency factor for choke area calculation is 0.8	5	CO1

Course Outcomes

CO1: Learn different types of casting process.

CO2: Select suitable manufacturing process for typical components.

CO3: Learn the various welding process.

CO4: Explain the concept of forging, rolling process and drawing.

NITDGP/BTECH/Reg/Even/2021-22

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MEC403 Full Marks: 30

Course Name: Heat and Mass Transfer Time: 90 Minutes

Question Paper No.: NITDGP/MEC403/Your Roll Number Date of Exam: 27/04/2022

Instructions: Answer all the questions.
Assume suitable data if needed.

Question No.	Body of the Question	Marks	Mapped CO
1	Write down the mathematical expression for first law of thermodynamics for open system.	2	CO1
2	Stated that in the boundary layer conduction=convection. Determine convective heat transfer coefficient in terms of temperature gradient applying Fourier's law of conduction.	2	CO2
3	Write down the mathematical expression for momentum theorem.	2	CO3
4	Write down the generalized conservation equation of the form Rate+Convection=Diffusion+Source in terms of divergence and gradient operations.	2	CO3
5	Write down the form of mathematical correlation for Nusselt number involving Reynolds number and Prandtl number for forced convection.	2	CO3
6	Determine all the view factors for an enclosure formed by two spheres. What do you mean by band emission?	2	CO4
7	Calculate the heat flux emitted due to thermal radiation from a black surface at 6000 K.	2	CO4
8	Deduce the reciprocity relation. What is summation rule?	2	CO4
9	Sketch and explain the Oppenheim's network representation for a three-surface enclosure with one surface reradiating.	2	CO4
10	Write the definition of mass transfer. Write Fick's law of diffusion.	2	CO5
11.	Derive one dimensional time dependent heat conduction equation with internal heat generation and constant thermal conductivity in Cartesian coordinate system.	3	CO1
12.	From the energy equation derive the expression of non-dimensional form of temperature and rate of heat transfer through an **infinitely long cylindrical fin.**	4	CO2
13.	The temperature of the inner side of a furnace wall is 640°C and that of on other side is 240°C and it is exposed to atmosphere at 40°C. In order to reduce the heat loss from the furnace, its wall thickness is increased by 100%. Calculate the percentage decrease in the heat loss due to increase in wall thickness. Assume no change in properties except temperature.	3	CO2

Course Outcomes
CO1: Relation of thermodynamics and heat transfer.
CO2: Knowledge of Conduction mode of heat transfer.
CO3: Knowledge of Convection mode of heat transfer.
CO4: Knowledge of radiation mode of heat transfer.
CO5: Heat and mass transfer equipments.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MEC431
Course Name: Fluid and Thermal Engineering
Question Paper No.: NITDGP/MEC431/1

Full Marks: 30
Time: 1:30 Hours
Date of Exam: 28/04/2022

Instructions: Answer all questions.
Materials to be supplied: Steam table will be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
1	a) Classify systems. b) Define each type with example. c) How do you distinguish quantity and identity of matter?	1+3+1	CO3
2	Steam enters a turbine operating at steady state with a mass flow rate of 4600 kg/h. The turbine develops a power output of 1000 kW. At the inlet, the pressure is 60 bar, the temperature is 400°C, and the velocity is 10 m/s. At the exit, the pressure is 0.1 bar, the quality is 0.9 (90%), and the velocity is 30 m/s. Calculate the rate of heat transfer between the turbine and surroundings, in kW.	5	CO3
3	A silicon chip measuring 5 mm on a side and 1 mm in thickness is embedded in a ceramic substrate. At a steady-state, the chip has an electrical power input of 0.225 W. The top surface of the chip is exposed to a coolant whose temperature is 30°C. The heat transfer coefficient for convection between the chip and the coolant is 150 W/m2 · K. If heat transfer by conduction between the chip and the substrate is negligible, determine the surface temperature of the chip, in °C.	5	CO3
4	State and explain local , convective and total acceleration.	3	CO1
5	A two dimensional flow field is given by $4x^3yi - 6x^2y^2j$. Determine the velocity and acceleration at a point x = 2, y = 1.	5	CO1
6	State the assumptions behind Bernaulli's principle .	2	CO1
7	Define Hydraulic Grade Line (HGL) and Total Energy Line(TEL). With suitable diagram, explain them.	2+3	CO1

Course Outcomes
CO1: To learn the basics of Fluid Mechanics
CO2: To learn the basics of Hydraulic machines
CO3: To learn the basics of Thermodynamics
CO4: To learn the basics of Power Plant Engineering

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MEC 432 Full Marks: 30

Course Name: Mechanical design of equipment & component for chemical Engineering Time: 90 Minutes

Question Paper No.: NITDGP/MEC432/1 Date of Exam: 28/04/2022

Instructions: Assume any suitable data, if required. Answer in short and to the point in your own language.

Materials to be supplied: Graph paper shall be supplied, if required.

Question No.	Body of the Question	Marks	Mapped CO
	First Half *Answer all the questions.*		
1	An air-standard Diesel cycle has a compression ratio of 20, and the heat transferred to the working fluid per cycle is 1800 KJ/Kg. At the beginning of the compression process, the pressure is 0.1 MPa and the temperature is 15° C. Determine the pressure and temperature at each point in the cycle, the thermal efficiency and the mean effective pressure. [*Your solution must contain appropriate assumptions, intermediate steps and necessary reflections.*].	2+2+ 2+1 =**7**	CO1
2	Write the Kelvin-Planck and the Clausius statements of the second law; and, demonstrate the equivalence of the two statements.	**4**	CO2
3	Which is the more effective way to increase the efficiency of a Carnot engine: to increase T_1, keeping T_2 constant; or to decrease T_2, keeping T_1 constant. Given $T_1 > T_2$	**4**	CO2
	Second Half *Answer five questions from this half.*		
4	a) Why is a flat belt drive considered as a flexible drive? b) Mention, in short, the major advantages of flat belt drive?	1 + 2=**3**	CO3
5	Among the larger pulley and smaller pulley, which pulley is considered as the basis for design of a flat belt drive for power transmission? Explain your answer in short.	**3**	CO3
6	What do you understand from "initial tension in a flat belt drive"? Derive an analytical relation between initial tension and maximum power transmission for a flat belt drive from the fundamental equation of belt tensions for flat belt drive.	**3**	CO3
7	For a horizontal flat belt drive, specifications are given below. Centre to centre distance for pulleys = 1.8 m Diameter of larger pulley = 800 mm Diameter of smaller pulley = 200 mm Calculate a) Angle of contact of belt with smaller pulley b) Angle of contact of belt with larger pulley c) Length of flat belt d) Angular velocity transmission ratio e) Average toque transmission ratio	½ + ½ + 1 + ½ + ½ = **3**	CO3

Course Outcomes

CO1: To develop a workable idea of the thermo-mechanical behaviour of industrial equipment used in various chemical industries.

CO2: To study the application of different thermodynamic principles for thermal system design

CO3: To learn the concepts of stress and strain, the properties of engineering materials, and the methods of machine design pertaining to chemical engineering

8	An air receiver, consisting of a cylinder closed by hemispherical ends, is made of steel FeE 230. The inner diameter of the cylinder is 500 mm and the operating pressure is limited to 3.5 MPa. Assume a factor of safety of 2.5. Treating the air receiver as thin cylinder, calculate the thickness of the cylinder wall and that of hemispherical ends. The yield strength of steel FeE 230 may assumed as 230 MPa. Neglect the effect of welded joint.	3	CO3
9	Derive an analytical expression for the wall thickness of a thick cylinder made of any brittle material, using maximum principal stress theory of failure. The cylinder is subjected to internal pressure only.	3	CO3
10	Write a short note on any one of the following. a) Creep phenomenon of belt in flat belt drive. b) Compounding of cylinders	3	CO3

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester End-term Examination, 2021-22

Course Code: MEC601

Course Name: Power Plant Engineering

Question Paper No.: NITDGP/MEC601/Your Roll No.

Full Marks: 30

Time: 90 Minutes

Date of Exam: 18/04/2022

Instructions: Answer all the questions.
Assume suitable data if needed.

Question No.	Body of the Question	Marks	Mapped CO
1	Derive the critical pressure ratio for a steam nozzle and write down its physical significance.	3	CO1
2	'Regeneration is an approach of making the Rankine Cycle to a Carnot Cycle'- justify the statement with necessary derivation.	3	CO1
3	Define the terms: (i) Sphericity (ii) Circulation ratio	2	CO1
4	Write short note on cascading type of condensate disposal system for closed feed water heaters.	2	CO2
5	A bed of particles of mean size 430 μm was found to have a density when loosely packed of 1600 kg/m^3, the density of the individual particles was 2800 kg/m^3 and their sphericity was 0.65. Calculate the minimum fluidization velocity when fluidized by air under ambient conditions, where the air density is 1.21 kg/m^3 and the viscosity is 1.82 x 10^{-5} kg/m.s.	3	CO1
6	Draw the Carnot cycle and Rankine cycle on T-S plane, derive the cycle efficiencies in terms of temperatures only, and write the difference between the two.	4	CO1
7	Draw the cut section, variation of velocity and pressure during flow in a simple impulse turbine.	3	CO2
8	Why are steam turbines compounded? What are the different methods of compounding?	2	CO2
9	With necessary sketches describe the working principle of an entrained flow gasifier.	3	CO2
10	The steam parameters at turbine inlet is 170 bar and 500°C and condensed at 8 kPa bar in a condenser. If one closed heater is placed optimally, draw the flow diagram, T-s diagram and find the cycle efficiency when drip is put forward with a drip pump. Neglect pump work. Consider TTD= 0.	5	CO1

Steam pressure (bar)	Steam Temperature (°C)	Enthalpy (kJ/kg)				Entropy (kJ/kg.K)			
		h_f	h_{fg}	h_g	h_{sup} @ 500° C	s_f	s_{fg}	s_g	s_{sup} @ 500° C
170	352.3	1691.6	860.0	2551.6	3283.6	3.811	1.375	5.186	6.264
14.5	196.9	837.5	1951.4	2788.9	-	2.299	4.154	6.453	-
0.08	41.5	173.9	2403.2	2577.1	-	0.593	7.637	8.230	-

Course Outcomes
CO1: Study of power production
CO2: Study of some power plant related equipment.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

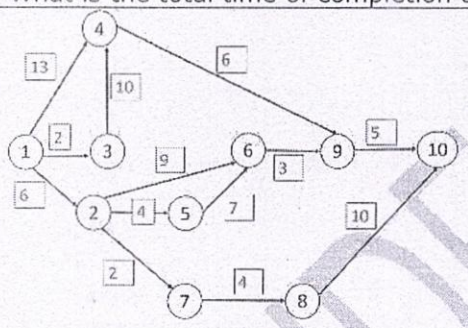
Even Semester End-term Examination, 2021-22

Course Code: MEC602 Full Marks: 30

Course Name: Industrial Engineering and Measurement Time: 90 minutes

Question Paper No.: NITDGP/MEC602/1 Date of Exam: 19/04/2022

Instructions: Answer all questions. Make a neat and well labeled diagram wherever necessary.
Materials to be supplied: NIL

Question No.	Body of the Question	Marks	Mapped CO
1	Duration of activities are given in brackets, next to them. A (2 weeks) and B (4 weeks) can be performed in parallel. C (2 weeks) and D (4 weeks) can not start until A is complete. E (6 weeks) cannot start until half the work of activity C is complete. F (4 weeks) can start only after activity D is complete. G (5 weeks) succeeds C. H (4 weeks) is the last activity and it succeeds E. Draw the bar chart. What is the total time of completion of the project?	5	CO2
2	 For the given network diagram find Earliest Expected Time and Latest Allowable Occurrence time for each events and EST, EFT, LST, LFT, Total Float and Free Float for all the activities. Show full calculations wherever necessary.	10	CO2
3	Calculate the limits of sizes for Diameter 20 P_7/h_6 and identify the fit. **Table is provided at end of question paper.**	5	CO5
4	In a bush and pin assembly, pin of 30 mm diameter rotates in a bush. The tolerance for pin is 0.025 mm while for bush is 0.04 mm. If allowance is 0.1 mm, determine dimensions of pin and bush **considering hole-basis system.**	5	CO5
5	If the size of a bearing (hole) to be checked is $30^{+0.04}_{-0.04}$ mm. Find the dimensions of a plug gauge considering unilateral and bilateral tolerance. If in the above example 5% wear allowance is given on work tolerance, then find also the dimensions of above plug gauge.	5	CO5

Course Outcomes
CO1: Knowledge on the structures of Engineering Organization in general.
CO2: Planning of manning and production line.
CO3: Ability for material management.
CO4: Indian standards of measurement.
CO5: Techniques of engineering measurements with its application.

Table:

FUNDAMENTAL TOLERANCES OF GRADES 01, 0 AND 1 TO 16

Diameter steps in mm	Values of tolerance in microns (1 micron = 0.001 mm)																	
	Tolerance grades																	
	01	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14*	15*	16*
To and inc 3	0.3	0.5	0.8	1.2	2	3	4	6	10	14	25	40	60	100	140	250	400	600
Over 3 To and inc 6	0.4	0.6	1	1.5	2.5	4	5	8	12	18	30	48	75	120	180	300	480	750
Over 6 To and inc 10	0.4	0.6	1	1.5	2.5	4	6	9	15	22	36	58	90	150	220	360	580	900
Over 10 To and inc 18	0.5	0.8	1.2	2	3	5	8	11	18	27	43	70	110	180	270	430	700	1100
Over 18 To and inc 30	0.6	1	1.5	2.5	4	6	9	13	21	33	52	84	130	210	330	520	840	1300
Over 30 To and inc 50	0.6	1	1.5	2.5	4	7	11	16	25	39	60	110	160	250	390	620	1000	1600
Over 50 To and inc 80	0.8	1.2	2	3	5	8	13	19	30	46	74	120	190	300	460	740	1200	1900
Over 80 To and inc 120	1	1.5	2.5	4	6	10	15	22	35	54	87	140	220	350	540	870	1400	2200
Over 120 To and inc 180	1.2	2	3.5	5	8	12	18	25	40	63	100	160	250	400	630	1000	1600	2500
Over 180 To and inc 250	2	3	4.5	7	10	14	20	29	46	72	115	185	290	460	720	1150	1850	2900
Over 250 To and inc 315	2.5	4	6	8	12	16	23	32	52	81	130	210	320	520	810	1300	2100	3200
Over 315 To and inc 400	3	5	7	9	13	18	25	36	57	89	140	230	360	570	890	1400	2300	3600
Over 400 To and inc 500	4	6	8	10	15	20	27	40	63	97	155	250	400	630	970	1150	2500	4000

* Upto 1 mm, Grades 14 to 16 are not provided.