DATE: 09/12/2019   **Maximum Marks: 80 (Weightage 40%)**
Time: 3 Hours

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Instructions:
- All parts of a question must be answered in sequence.
- Support your answer with neat sketches.
- Printed Data Tables are permitted in examination hall

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Q.1
a) A simulation study was performed to study the solidification of a casting process in a symmetric mould. The distance of the mould wall from the center line was found to be 100 cm. A transient heat transfer analysis revealed that the solidification started at the walls 15s after pouring while it commenced after 40s at the mould center line. It was completed after 90s at the walls and 120 s at the mould center line. Find the center line feeding resistance (CFR) and discuss your results.

For the above process, when chillers were used around the mould, it was found that the solidification began within 4s after pouring and ended after 15s. For the center line it started and ended after 50s and 70s respectively. Find the CFR in this case and comment on your findings. Justify your answers with neat sketches for both the situations described above.   **[8]**

b) Estimate the time required to fill up the cylindrical mould (in seconds) as shown in Fig. 1.Assume that the liquid metal level in at X-X is maintained constant and the time to fill the runner is negligible. Use the following constants for your calculations: ρ_m=6000 kg/m3, η=0.00165 kg/m-sec, f(runner)=0.0025, (L/D)eq for 90^0 turn=25,e_f (Contraction)=0.1,β=1.0, , e_f (Enlargements for levels below Y-Y)=0.0,e_f (Enlargements for levels above Y-Y)=1.0.   **[7]**
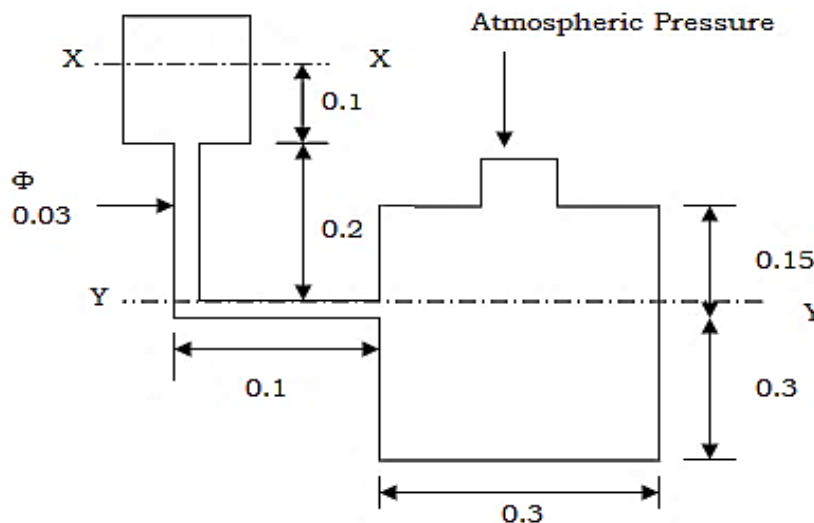

Fig. 1 Mould Filling (All Dimensions are in m)

Q.2

a) Three castings of same material and volume are cast under similar conditions. One is sphere; other is cube and third is cylinder with its length being equal to diameter. Find the ratio of solidification time of i) Sphere to Cube and ii) Sphere to Cylinder. **[7]**

b) Draw a table to compare the allied drilling operations viz. Tapping, Reaming, Counter-boring, Countr-sinking and Spot facing as follows:

Name of allied operation, sketch of the operation, the purpose for which the operation is carried out. (Note: no weightage will be given if tabular comparison is not done). **[8]**

Q.3

An Aluminum (*Al*) strip of 200 mm width and 6 mm thickness is to be rolled to achieve a 50 % reduction in thickness. For this purpose, steel rollers of diameter 250 mm are used having a rolling speed of 35 m/min. The shear yield stress of *Al* can be taken as 160 N/mm$^{2.}$ Determine:

a) The location of neutral point considering minimum coefficient of friction (unaided bite);

b) The roll separating force. Plot the rolling pressure in the regime of contact angle, based on the above values**. [15]**

Q.4

A 30 mm x30 mm x 120 mm M.S. plate is forged in an open die forging having two flat dies to a dimension of 15 mm x 60 mm x 120 mm. Determine the peak forging force assuming μ=0.2 and draw the forging pressure distribution considering half symmetry of the plate. Assume that steel follows approximately linear strain hardening characteristics having tensile yield stress of 207 MPa and tensile strength of 500 MPa at a true strain of 0.8. Further the effective yield stress can be taken as average of yield and actually strained conditions. Note: Assuming that the material behaves same in tension and compression take absolute value true strain in this case as *ln* (15/30). Use Von Mises Criterion to find the shear yield strength **[15]**

Q.5

a) Turbine blades and vanes are to be produced to cater the power generation market. These are to be produced from Chromium alloys in bulk quantity. With neat sketches and suitable justification, explain the most appropriate method of manufacturing these components. **[5]**

b) With neat sketches, explain the welding process which does not involve use of any electrical power source and is analogues to a typical process of casting. Discuss its application. **[5]**

Q.6

a) A hole and a shaft have a basic size of 30mm, and are to have a clearance fit with maximum and minimum clearance of 0.02 and 0.01mm respectively. The hole tolerance is to be 1.5 times the shaft tolerance. Determine the limits for both shaft and hole using basic shaft system**. [5]**

b) During a particular operation in a lathe machine, the countershaft pulley of 60mm diameter transmits power to a 180 mm diameter pulley mounted on spindle shaft. The same shaft has pinion and gear of 20 and 100 teeth while there is conventional back gear arrangement with 100 and 20 teeth. Find the rpm of spindle if back gears are engaged during the operation and countershaft pulley rotates at 300 rpm. Plot the schematic of the arrangement. **[5]**