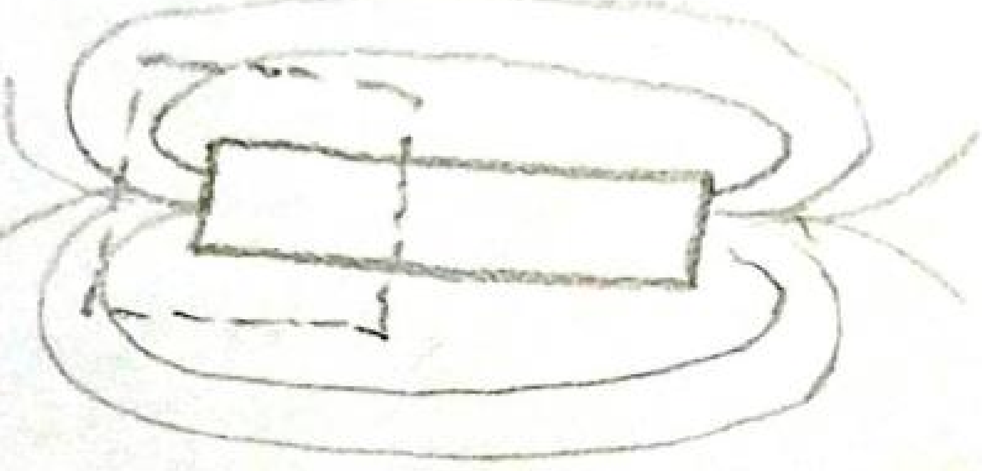
5.1

1. $\vec{\nabla}\cdot\vec{B}=0$ This states that the divergence of the magnetic field at any location is 0, which means the same amount of magnetic field is flowing into a defined region as flowing out of it. If we look at a space around the pole of a dipole magnet, it may look like a positive ~~divergence~~ (or negative) divergence, (1), but if this magnet were to be cut into a size smaller than our area, we would see that the divergence is, in fact, still 0 (2).

Flux

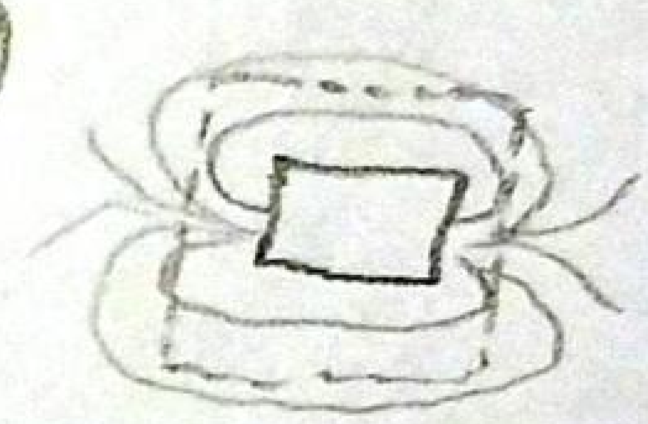
Flux flowing in/out balance is appealing to the this equation after application of the divergence theorem. So your answer is not really using the differential form of this equation.

(1)



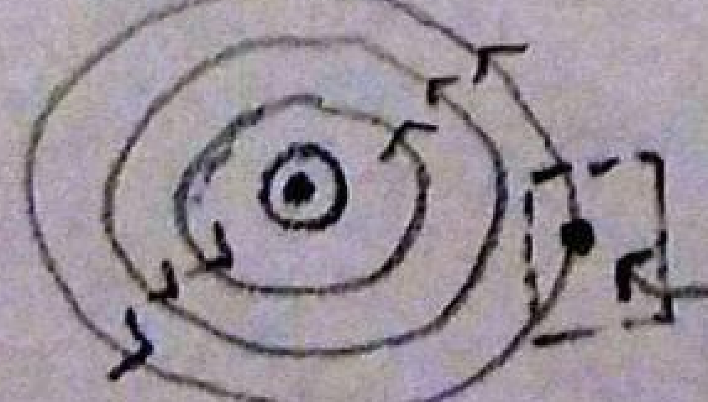
Somewhat misleading diagram b/c field inside solenoid is not drawn.

(2)



2. $\vec{\nabla}\times\vec{B}=\mu_0\vec{J}$ This states that the curl of the magnetic field is proportional to the current density. The magnetic field rotates about the direction of current. In the case of a line current, the magnetic field rotates perpendicular to the wire (3). If ~~a~~ the curl were taken of another point along the $\vec{B}$ field where there is no enclosed current, the curl would be 0.

(3)



$\vec{\nabla}\times\vec{B}=0$ since $\vec{J}=0$ within the region

Have a look at the paper that I posted. It show a better diagram of what this means. Also look into the derivation of the curl based on a limit of a loop integral.

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3. $\vec{B} = -\vec{\nabla}\varphi_m$ This describes the magnetic field in the case of no currents, such as a permanent magnet. In this case, $\vec{\nabla} \times \vec{B} = 0$ with no current but still holds true for a scalar product.

Should really appeal to the mathematics that allow you to write B in terms of a scalar potential or state that by analogy with curl E = 0, this is possible.